THE

ONTARIO WATER RESOURCES

COMMISSION

LAKEHEAD AREA

REGIONAL WATER SUPPLY

AND

POLLUTION CONTROL STUDY

MAY 1969

THE

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LIST OF ABBREVIATIONS

Twp.	-	Township	
R.	-	River	
Cr.	-	Creek	
I.	-	Island	
CFS, cfs	-	cubic feet per second	
gpm	-	gallons per minute	(Imperial)
gpd	-	gallons per day	"
gpcd	-	gallons per capita per day	"
MGD, mgd	-	million gallons per day	"
mg	-	million gallons	"
ppm	-	parts per million	
ppb	-	parts per billion	
c.c.	-	cubic centimetres	
lb.	-	pound(s)	
ft.	-	feet	
mi.	-	mile(s)	
sq.	-	square	
cu.	-	cubic	
wk.	-	week	
^{o}F	-	degrees Fahrenheit	
%	-	per cent	
No.	-	number	
avg.	-	average	
max.	-	maximum	
min.	-	minimum	
Log.	-	logarithmic	
N.A.	-	not available	
Est.	-	estimated	
Pop.	-	population	
BOD, BOD_5	-	5-Day Biochemical Oxygen Demand	
COD	-	Chemical Oxygen Demand	
S.S.	-	suspended solids	
Susp.	-	suspended	
Diss.	-	dissolved	
Hex.	-	hexavalent	
M.P.N.	-	most probable number	
Co.	-	Company	
Ltd.	-	Limited	
Ind.	-	Industrial	
Cont'd	-	continued	
Lab.	-	Laboratory	
WPCP	-	water pollution control plant	
OWRC	-	Ontario Water Resources Commission	
H.E.P.C.	-	Hydro-Electric Power Commission of Ontario	
C.P.R.	-	Canadian Pacific Railway	
C.N.R.	-	Canadian National Railway	

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I

INTRODUCTION

PURPOSE

Development in the Lakehead has been steady during the last 15 years. The amount of undeveloped land within the boundaries of the two urban municipalities, the Cities of Fort William and Port Arthur, is diminishing with the result that pressure for growth in the rural areas is becoming more evident. Before extensive urbanization of the fringe areas occurs, servicing plans based on sound policies for water supply and pollution control will be required to guide development in the most satisfactory directions. Therefore, this study has been undertaken to provide the necessary planning for supplying water to the developing areas and at the same time providing the pollution control facilities required to maintain and improve the water resources of the Lakehead.

SCOPE

The report briefly describes the geography of the region, the existing development and land use patterns and the population trends. In addition, an inventory of the water resources of the region including ground-water availability and streamflow is included. The existing water supply and pollution control facilities, municipal, industrial and private have also been summarized with regard to existing capacity and performance.

On the basis of these considerations, the future population and land use patterns have been forecast. The required water supply and pollution control facilities

have been determined. The projections have been made for a period of 50 years during which it is expected that development in the area will have reached its "ultimate" extent as designated in this report. It should be noted that the development pattern outlined in the report was chosen after consultation with the local, area and provincial planning authorities and also to facilitate the servicing of the land.

II

SUMMARY AND RECOMMENDATIONS

SUMMARY

The Lakehead study area encompasses some 460 square miles of land in and around the largest urban area in Northern Ontario. The steady rate of growth which this area has exhibited during recent years is expected to continue, so that in 20 years a population of 155,000 persons is estimated. The majority of these people will reside in the urban area comprised of the existing Cities of Fort William and Port Arthur and the bordering Municipalities of Neebing and Shuniah. If the anticipated development is to be realized in this urban area, adequate water supply and pollution control facilities will be required. Although the water resources of the area are abundant, proper management of these resources will be necessary both for their protection and for the sake of economy in their utilization as sources of water supply and as the means of disposal of properly treated waste effluents.

In reviewing the existing water supply and pollution control facilities in the two cities, many inadequacies were apparent especially in regard to pollution control. In addition to overcoming these existing inadequacies, extensive new works will be required to provide the necessary water and sewer services in the developing areas of Neebing and Shuniah. Careful assessment of priorities will be difficult but essential in determining staging programmes for the construction of these works.

It was concluded that the two water supply systems should be integrated and operated as a single utility in the future. The information available has suggested that the Loch Lomond watershed has a perennial yield of about 12 mgd. The existing gravity supply system to Fort William has a capacity of 16 mgd which could be increased by providing additional storage at the present reservoir site. The simplicity of this system results in economical operation. In order to continue to utilize this source of supply to its full potential, additional hydrologic data is required. Therefore, it is suggested that a permanent recording flow gauging station be installed at the natural outlet of Loch Lomond. A meteorological station should also be established for measurement of precipitation and air temperature. In addition, bi-weekly snow surveys during the winter months would be useful. The present Port Arthur water system is limited to a capacity of approximately 9 mgd by the feeder mains from the plant to the developed area of the city. An additional feeder main will be required eventually. Integration of the two systems would delay this feeder main for some time as the supply from Fort William would relieve the inadequacies that exist in the southern end of the Port Arthur distribution system. The intakes at the Bare Point pumping station are adequate for at least 20 years. An intensified programme of monitoring the raw water quality would provide more adequate information upon which to decide whether additional treatment is required at the Port Arthur water works. The lack of emergency storage facilities on both systems will be overcome to some extent by the integration of the two systems. The construction of the new feeder mains to serve newly developing areas west of the

two cities together with storage facilities in these areas as recommended should provide the required protection for fire and emergency purposes.

Industrial water use in the Lakehead is very significant. In 1967 industry accounted for more than 30 per cent of Fort William's average daily consumption. Close scrutiny of industrial consumption would ensure that industry's contribution to the system relates to the benefits derived from its use of the system both now and in the future.

The inadequacies in the present pollution control systems in the Lakehead urban area are numerous. These include: the lack of connection between sewered areas and the treatment plants resulting in direct discharge of domestic wastes to surface waters; the lack of separation of storm and sanitary sewage flows; the lack of satisfactory treatment of industrial and domestic wastes; and the lack of capacity for newly developing areas in the systems. The review of pollution control facilities was divided into two main categories: treatment and collection.

It was concluded that treatment should be provided at a single plant rather than at two plants as at present. Economic considerations were significant in reaching this conclusion. It was determined that the treatment facilities should be located at the site of the existing Fort William water pollution control plant. The ultimate degree of treatment would provide greater reductions in BOD and suspended solids than primary treatment and would also reduce

nutrients to acceptable levels. Effluent would be discharged to Lake Superior. Interim stages in the development of the ultimate treatment facility could be either a primary treatment plant discharging to Lake Superior which could later be converted to the type of treatment outlined above and referred to in this report as "intermediate treatment"; or intermediate treatment discharging effluent to the Kaministikwia River initially and eventually to Lake Superior.

Industries were classified according to the direction their pollution control programmes should take in the future. Basically the classification is self-explanatory and includes categories for industries providing their own waste treatment prior to discharge to a watercourse, those not presently connected to the municipal water pollution control system which probably require pretreatment of their wastes prior to discharge to the system, those presently discharging wastes of significant volume or strength to the municipal systems, those discharging wastes of little or no significance to the municipal systems and finally those with no significant industrial waste disposal problems. The industrial water pollution control problem is merely identified in this report; no attempt is made to define the works required for each industry. In the consideration of the municipal pollution control facilities however, allowances were made for wastes from the industries which, according to the preceding classification, would discharge to the municipal systems.

In reviewing the collection systems, the study concluded that an extensive sewer construction programme is required

in the Lakehead urban area to connect presently developed areas to the treatment facility and to accommodate new areas of development. Furthermore, a conscientious sewer separation programme is required. All new areas to be served must be provided with separate storm and sanitary sewers.

The integration of the existing water supply and pollution control systems will represent a departure from the servicing policies which have been pursued in this area in the past. Recently however, the Provincial Government has announced plans for the amalgamation of the Cities of Fort William and Port Arthur and the Geographic Townships of McIntyre and Neebing. This should serve to consolidate the policy of integrating services which, as mentioned previously, was based on considerations of simplicity and efficiency of operation and economics.

The summarization of the conclusions of the study thus far has pertained solely to the urbanizing areas of the Lakehead. Although growth is not anticipated to the same extent in the inland communities, some expansion will probably occur. The available information suggests that ground-water development for municipal purposes is not practical. The use of surface supplies as an alternative would be quite expensive. Similarly the assimilation capacity of inland watercourses may not be sufficient to allow the discharge of effluent from a municipal water pollution control facility. Under either of these circumstances, the growth of an inland community would of necessity be restricted to a degree that could be adequately

served by individual water supply and pollution control facilities such as wells and septic tank and tile field systems.

RECOMMENDATIONS

General

1. Policies should be adopted to encourage urban development only in areas which are compatible with the provision of both communal water supply and pollution control services. These areas would include the Cities of Fort William and Port Arthur and those parts of the Municipalities of Neebing and Shuniah bordering on the western boundaries of the two cities.

2. A long range development limit should be defined in order that the necessary services can be designed accordingly. The extent of ultimate development as outlined in Figure III-2 of this report might be used as an example of such a definition.

3. Within this limit development stages should be devised in order that similar stages for the proposed water supply and pollution control facilities can be adopted.

4. Growth outside of a development limit should be carefully supervised to ensure that its extent does not require communal services unless such facilities can be provided readily.

5. Suitable land-use designations in an Official Plan and restricted area (zoning) by-laws should be adopted by the municipalities to guide and control development as outlined in the previous four recommendations.

Water Supply

1. The two existing water supply and distribution systems in the Cities of Fort William and Port Arthur should be integrated and operated as a single facility.

2. A detailed network analysis should be undertaken to determine deficiencies that may be inherent but not obvious, in the existing distribution systems when they are integrated.

3. The integrated system should be extended as required to serve future urban development in the Lakehead. This report outlines a possible method of providing the necessary additions to the existing systems.

4. Detailed hydrologic data should be obtained for the Loch Lomond watershed in order that the management of the resource for water supply purposes can be optimized. To accomplish this the following will be required: -

(a) the construction of a streamflow gauging station at a suitable location on the natural outlet of Loch Lomond

(b) the establishment of a meteorological station in the basin to record daily air temperatures and precipitation

(c) the bi-weekly measurement of the areal extent and depth of snow cover and its water equivalent.

5. The routine inspection of the gravity feeder mains from Loch Lomond should be continued.

6. An intensified programme of monitoring raw water quality at the Bare Point Pumping Station should be adopted to provide more adequate information upon which to decide whether additional treatment is required.

7. Additional storage facilities should be provided to satisfy peaks in consumption and fire and other emergency requirements.

8. The total water consumption for the urban area should be reviewed regularly to ensure that adequate capacity is available to meet the increasing demands. As industrial water consumption constitutes a very significant proportion of the total demand in the Lakehead, this review should also include an assessment of the contribution of industry in comparison to benefits derived to ensure an equitable rate structure.

9. Grand Point should be considered as the location for future water supply works when the capacity of the existing facilities is reached. Consideration should be given therefore to protecting a site for this purpose.

Pollution Control

1. Pollution control for the Lakehead urban area should be provided by a single treatment plant located at the site of the existing Fort William WPCP.

2. The primary facilities at the Fort William WPCP should be enlarged to treat the wastes from the entire urban area and an outfall sewer extending into Lake Superior beyond the breakwall to a water depth of approximately 24 feet should be constructed; -

OR

the existing Fort William WPCP should be converted to intermediate treatment such as chemical precipitation, and expanded as required to treat the wastes from the entire

urban area. The effluent could then continue to be discharged to the Kaministikwia River until the design period flow is reached.

3. A detailed economic analysis of the two alternatives outlined in Recommendation 2 should be undertaken to determine which would be the most suitable during the initial design period. The preliminary evaluation undertaken during this study indicated that both schemes were approximately equal in cost and would provide adequate protection of the water resources.

4. The degree of treatment ultimately provided by the pollution control facilities serving the urban area, based on present information and estimation, should be of at least an intermediate type with effluent discharge to Lake Superior.

5. The present Port Arthur WPCP should be converted to a sewage pumping station which would be connected to the trunk sewer system as outlined in Figure VI-1.

6. The present programme of sanitary trunk sewer construction should be accelerated to intercept all sewers now discharging raw wastes to surface waters. In addition, the programme should be expanded to provide sewers to presently unserviced lands according to priorities to be established by the local authorities.

7. The practice of separating storm and sanitary sewage flows for new development should be continued. The existing combined flows should be separated wherever and whenever economically practical.

8. An adequate sewer use by-law outlining permissible limits for strength and volume of waste discharges should be enacted and enforced to protect the public investment in sewers, pumping stations and treatment facilities, and the water resources of the area.

9. Arrangements should be made, without delay, whereby industrial wastes which are amenable to treatment at the municipal water pollution control plant and are presently discharged to surface waters in an untreated or inadequately treated state would be discharged to the sanitary sewer system.

10. Industries which due to waste composition or volume will continue to discharge waste effluents directly to surface waters should provide the treatment facilities required without delay to maintain surface water quality as specified in the Water Quality Objectives, Policy Guidelines, adopted by the Ontario Water Resources Commission in June, 1967.

III

GENERAL

DESCRIPTION OF STUDY AREA

The study area includes the Cities of Fort William and Port Arthur, the northern portion of the Municipality of Neebing, the south-western portion of the Municipality of Shuniah, the Townships of Oliver and Paipoonge and the unorganized Townships of Gorham and Scoble. This comprises the land within the watersheds of the McVicar Creek, the McIntyre River and the Neebing River, the land within the watershed of the Kaministikwia River downstream from the flow gauging station at Kaministikwia exclusive of the lands on the west side of the river between Kaministikwia and Kakabeka Falls, and the major portion of the Whitefish River Basin which drains to the Kaministikwia River, and last, but not least, the entire Loch Lomond-Lomond River (Carp River) drainage system. Figure III-1 outlines the study area boundary, which encompasses some 460 square miles of land.

Topography

The main physiographic features of the study area are the steep-faced, flat-topped hills containing the Loch Lomond drainage system, the terraced geography of the Current River drainage basin and the large triangular plain situated in between these uplands. Each of these features is significant when considering water supply and pollution control services. The topography of the uplands would make the construction of services very difficult. On the other hand, the installation of services in the large plain or delta

which extends from the base of the Loch Lomond hills to the junction of the North and South Neebing Rivers and from there back to a point on Lake Superior approximately half-way between the mouths of the McVicar Creek and the McIntyre River could be readily accomplished making it the logical choice for urban development.

Drainage

The main drainage systems in the area are the Loch Lomond-Lomond River (Carp River), the Kaministikwia River, the Neebing River, the McIntyre River and the Current River systems. All of these systems discharge directly to Thunder Bay as do the smaller Whiskeyjack and McVicar Creek systems. The Kaministikwia River divides into three branches, the Mission River, the McKellar River and the Kaministikwia River, before it empties into Thunder Bay. The physical characteristics of all of the watercourses are outlined in Table IV-1 in Section IV. Streamflow records are also contained in that section.

Climate

The climate in general is moderated by the proximity of Lake Superior. The monthly average temperatures in the Lakehead vary from $7^{\circ}F$ in January to $63^{\circ}F$ in July. The average annual precipitation is approximately 30 inches. The average length of frost-free period is 90 to 112 days with an average growing season of 160 days.

POPULATION

The study area population has increased at the average rate of 2.1 per cent per year since 1952 based on figures

obtained from the Municipal Directories published by the Ontario Department of Municipal Affairs. During this same period, the average growth rate for the individual municipalities has varied from a high of 4.5 per cent per year (Shuniah) to a low of 0.9 per cent per year (Oliver). In comparison, the average growth for the area during the last five years has been only 0.9 per cent per year. Discussions with staff of the various planning authorities having jurisdiction over the area, have led to the conclusion that future growth rates may be relatively slow until the total population reaches the 200,000-250,000 range. It has been suggested that secondary and service industry cannot flourish until a built-in market of this magnitude is available. At the present time the economy is based largely on primary industry utilizing the abundant raw materials of the area. It would appear that this field can be greatly expanded in the future.

The projected future population figures shown in Table III-1 were derived ignoring existing municipal boundaries. These projections were based on the assumption that all of the amenities necessary for growth would be provided.

Figures for 1988 have been used for design purposes and those in the "ultimate" column should be considered to be educated guesses of the possible population present some time after the year 2000. These latter figures were acknowledged in the design of works to ensure that they could be serviced in the future.

LAND USE

No attempt was made to delineate the specific land use within the study area. Rather, an attempt was made to determine the lands that would be occupied by urban development. Figure III-2 indicates the extent of existing urban development together with the lands that may be urbanized up to and beyond 1988. The areas shown up to 1988 agree closely with the development shown in the proposed Lakehead Official Plan.

A definition of the staging and ultimate extent of development in the area would be useful in proposing water supply and pollution control programmes. Conversely only those areas wherein it is feasible to provide satisfactory services should be considered suitable for urban development. Ideally a development limit could be defined inside which complete urban services could and would be provided. Outside of this limit, growth would be discouraged unless it could be accommodated by individual services such as wells, and septic tank and tile field disposal systems.

TABLE III-1

PRESENT AND PROJECTED FUTURE MUNICIPAL EQUIVALENT POPULATIONS

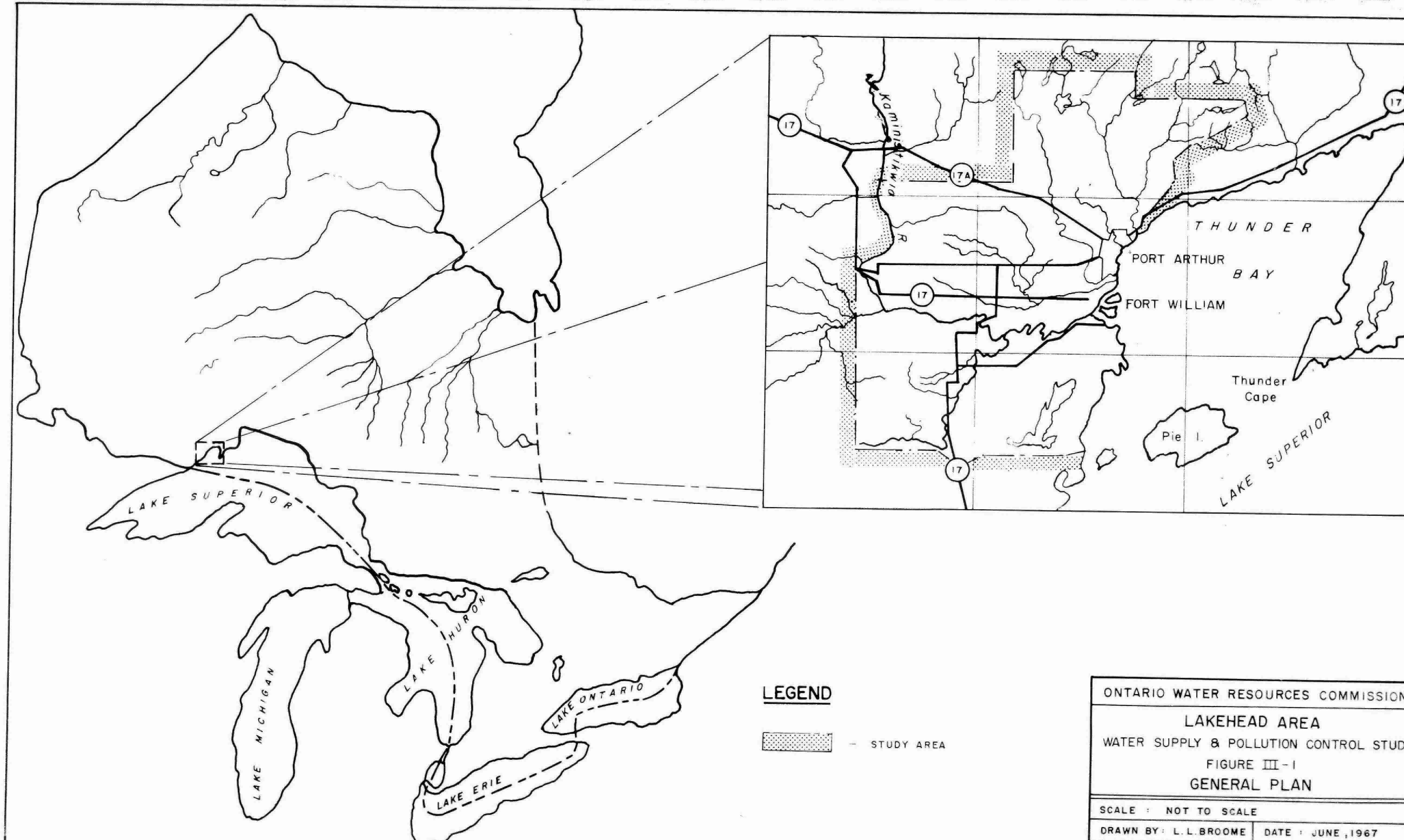
	1967 Assessed Population*	1973	1978	1988	Ultimate**
Cities					
Fort William	48,203	54,300	59,000	68,700	92,500
Port Arthur	46,718	52,600	58,100	68,500	92,200
Townships					
Oliver	1,233	1,300	1,400	1,500	1,800
Paipoonge	2,204	2,600	2,800	3,200	3,700
Municipalities					
Neebing (1)	3,893	4,300	4,600	5,300	7,200
Shuniah (2)	5,926	6,900	7,600	8,600	9,900
TOTAL	108,177	122,000	133,500	155,800	207,300

* - Obtained from 1968 Municipal Directory published by the Ontario Department of Municipal Affairs.

**- Population estimated in shown urbanized area after the year 2000.

(1) Composed of the geographic Townships of Blake, Crooks, Neebing and Pardee. Only the geographic Township of Neebing and the northern part of the geographic Township of Blake included in the study area.

(2) Composed of the geographic Townships of MacGregor, McIntyre and McTavish. Only the geographic Township of McIntyre and the western part of the geographic Township of MacGregor included in the study area.



ONTARIO WATER RESOURCES COMMISSION	
LAKEHEAD AREA WATER SUPPLY & POLLUTION CONTROL STUDY FIGURE III - I GENERAL PLAN	
SCALE : NOT TO SCALE	
DRAWN BY: L.L.BROOME	DATE : JUNE, 1967
CHECKED BY: K.L.	DRAWING No: 67 - 42

IV

WATER RESOURCES

AVAILABILITY

Ground Water

The study of the ground-water resources of the region was based on data obtained from water-well records, and municipal ground-water surveys on file with the Division of Water Resources and from geologic maps and reports of the Ontario Department of Lands and Forests, the Ontario Department of Mines, and the Geological Survey of Canada.

In this report the term "aquifer" is used to mean a saturated, water-bearing bedrock or overburden formation that is capable of transmitting water in useable quantities. The ground-water resources study consists of an assessment of geologic and hydrologic characteristics of the bedrock and overburden aquifers.

Bedrock Aquifers

The bedrock formations of the region form a part of the Canadian Shield. Both early and late Precambrian rock types have been observed. Early Precambrian Algoman type rocks consisting of granite and other plutonic rocks are common in the northern portion of the region. Approximately south of a line joining Port Arthur and Whitefish Lake, which is to the west of the study area, the bedrock consists of late Precambrian rocks of the Animikie Series. These later rocks are a complex series of sedimentary and intrusive types. Wells obtaining water from the bedrock are commonly reported to encounter shale and slate of the

Animikie Series.

Water is apparently transmitted through openings of limited size such as fractures and joints in the bedrock. There does not appear to be a predictable water-bearing horizon as water has been encountered in bedrock penetrations varying from a few feet to as great as 390 feet.

Water yields from bedrock wells are usually low, reportedly ranging from less than 1 gpm to 16 gpm and averaging about 3 gpm. A rate of 3 gpm is sufficient to meet the needs of only one or two households.

Hydrogeologic evidence suggests that the low yields from bedrock wells can be attributed to the basically poor aquifer characteristics of porosity and permeability associated with the bedrock shales, slates and granites.

Static-level data from bedrock wells indicate that ground water moves through the bedrock under the influence of gravity toward the bedrock valley occupied by the Kaministikwia River and discharges as streamflow and underflow into Lake Superior.

Overburden Aquifers

The relatively flat plain lying to the west of Port Arthur and Fort William is occupied by the flood plain, delta and lacustrine deposits of the Kaministikwia River. In this area relatively thick sediments of glacial, glacio-fluvial and glacio-lacustrine origin were deposited in a preglacial bedrock depression during the Wisconsinan glacial period.

The following interpretation of the geologic history and a description of aquifers of the overburden deposits has been derived from a study of well logs and geologic reports.

1. A thin deposit of sand and gravel was deposited on the bedrock surface in some locations. The majority of overburden wells in the area appear to obtain water supplies from this formation. These wells have low yields.

2. An advance of an ice lobe through the valley, from the east, deposited a bed of relatively impervious clay till varying from a few feet to 90 feet in thickness.

3. The glacier retreated into the Lake Superior basin. On the till surface, small isolated sand and gravel beds were deposited in some localities. These may be spillway or reworked till deposits. Limited data indicate they may be associated with the present drainage systems and are recognized in wells drilled near the Neebing, Slate and Jarvis Rivers. These deposits form some of the better overburden aquifers of the area but have limited yields because of their small size and isolation in relatively impervious material.

4. Glacial lakes which had higher water levels than present Lake Superior were impounded in the Lake Superior basin. These lakes were fed in part from the Kaministikwia spillway which carried meltwaters from a more northerly ice front. At the mouth of the spillway near Kakabeka Falls, coarse gravels and sands were deposited where the fast moving spillway waters encountered a former glacial lake.

Finer materials such as sand, silt and clay were distributed on the lake bottom, which at the time of deposition occupied most of the present plain. The thick deposits of sand and gravel in the Kakabeka Falls area have been incised by the present Kaministikwia River. As a result, ground water is not stored in significant quantities because it can drain into the river. The sand bodies deposited in the delta within the glacial lake appear to be lenticular and discontinuous in nature. This is a typical feature of sub-aqueous deltaic sediments where considerable clay material is available for deposition. A few low-yield wells have been located in these sediments. The potential for locating high-capacity municipal wells in these sediments which form the bulk of the valley deposits is poor because the geologic environment was not suitable for the deposition of coarser sediments.

Yields from overburden wells are reported to vary from less than 1 gpm to 50 gpm and average about 4 gpm. Generally, overburden wells produce sufficient supplies for only one or two households.

Higher-yield wells in the 30 to 50 gpm range are reported at the Fort William Industrial Farm. A pumping test on one of these wells indicated that the aquifer is of limited size with a perennial yield of about 11 gpm.

Static-level data indicate that overburden aquifers may be hydraulically connected to the bedrock. The direction of ground-water movement in the overburden in and near the plain therefore, appears to be similar to that

in the bedrock.

Recharge

The recharge to aquifers is largely dependent on precipitation. Overburden and bedrock may receive recharge through local vertical leakage of precipitation and/or through lateral movement from distant recharge areas.

Recharge to ground water may be detected in three forms: ground-water runoff or base flow to streams, ground-water evapotranspiration, and change in ground-water storage.

Data are not available for calculating ground-water evapotranspiration or change in ground-water storage; however, an indication of the recharge rate may be obtained by determining the base flow, or ground-water runoff, of the rivers in the drainage basins of the study region.

Streamflow measurements, from which the base flow for the region can be derived, are limited. A reliable record of flow rates is available for only the Neebing River. As the Neebing River traverses both bedrock and overburden areas in the region, it can be considered indicative of base-flow conditions.

Rapid increases and decreases in Neebing River flow rates with varying precipitation and very low, base-flow rates during long dry periods tend to support hydrogeologic evidence that aquifer storage capacities and/or permeabilities are low.

The ground-water runoff estimated from the Neebing River hydrographs for the low-flow water years of 1957-1959 inclusive and those ending in 1963 and 1966 ranges from 50,000 to 125,000 gpd per square mile.

Availability

In the Lakehead study region, the majority of community growth appears to be centred in an area of 259 square miles which includes the Townships of Oliver, McIntyre, Paipoonge and Neebing and the Cities of Port Arthur and Fort William. Applying the lower ground-water recharge rate of 50,000 gpd per square mile, as a conservative measure, the calculated theoretical recharge amounts to 13 million gallons per day for this area. Not all of this recharge is available for capture by wells. The amount of water available to any well is largely dependent on the ability of the aquifer to transmit water. As the permeabilities of the bedrock aquifers and the clay deposits which enclose aquifers in the overburden are low, only a portion of the recharge is available for production.

In a hydrogeologic study conducted by the Illinois State Water and Geological Survey, it was estimated that the ground-water recharge available for extraction from wells drilled in glacial drift aquifers may amount to about 60 per cent of the ground-water runoff.

If a conservative figure of 50 per cent of the recharge is assumed to be available for withdrawal from wells, approximately 6.5 million gallons per day may be available for development. It is restated for emphasis that hydrogeologic

evidence indicates that only small amounts of water appear to be available at any single location.

Surface Water

The boundaries of the Lakehead Area Regional Study used for this section of the report do not follow the political boundaries of the region as defined elsewhere in the report, but rather, are based mainly upon natural drainage divides as shown in Figure IV-1.

Description of Thunder Bay

Thunder Bay, a major bay of Lake Superior, borders the Lakehead area. Consequent to its good harbour facilities at Port Arthur and Fort William, the cities are transfer points between rail and water transportation in an east-west direction. The water depth in the Port Arthur harbour, sheltered by offshore breakwaters, varies up to 28 feet.

Fort William harbour is located mainly in three channels at the mouth of the Kaministikwia River. In the harbour area the channels of the Kaministikwia and Mission Rivers are maintained at a 25-foot depth by dredging. The channel of the McKellar River, between McKellar and Mission Islands, has a natural depth of 17 to 26 feet, but the channel into Thunder Bay is maintained at a depth of 18 feet by dredging.

Thunder Bay has depths up to 49 fathoms or 294 feet. Its water level, as it is part of Lake Superior, is regulated by compensation works located in the St. Mary's River. The control works consist of dikes and sluice gates so operated as to vary the volume of discharge from Lake Superior and

to limit the fluctuation of the lake surface within a range between the elevations of low-water datum, 601.6 feet above Mean Sea Level, and 2 feet above this datum.

Descriptions of Streams

The Lakehead Area as shown in Figure IV-1 is drained by the Current, Kaministikwia, Lomond, McIntyre and Neebing River systems and the McVicar and Whiskeyjack Creeks. These streams all drain directly into Thunder Bay on Lake Superior.

The Current River drains an area of 265 square miles of which about 122 square miles lay within the study area. The dam at the outlet of Onion Lake regulates the runoff from about 143 square miles in the upper drainage basin of the Current River. The dam is about 16 miles upstream of the mouth of the Current River. The study region boundary was selected to pass through this dam. A second major control dam is situated about one-half mile upstream from the river's outlet. A hydro-electric power station is located there. The Current River is fast-flowing and has many rapids along its course. One major tributary, the North Current River, joins the Current River about four miles upstream of the second major control dam.

The Kaministikwia (Kam) River has a drainage area of about 3,020 square miles. The river is fed by several large lakes, the Shebandowan Lakes, which discharge through the Shebandowan River into the Kaministikwia, and Dog Lake where the Kaministikwia River begins. The discharges from these lakes are regulated through the operation of control dams. The boundary of the study region was arbitrarily selected at the streamflow gauging station at Kaministikwia.

Downstream from this point, the river flows in a general southerly direction until its course changes to an easterly direction about 3 miles downstream of Kakabeka Falls. The river is navigable from the mouth to the west limit of the City of Fort William for all lake and most ocean vessels. Smaller boats can navigate upstream to the rapids at Pointe de Meuron. The rapids in the river and the Kakabeka Falls restrict the use of the upper river for boating. The Kaministikwia River splits near its mouth into three channels, named from south to north, the Mission, McKellar and the Kaministikwia Rivers.

Streams that flow into the Kaministikwia River within the study area are, proceeding downstream from Kaministikwia: Strawberry Creek, Brûlé Creek, Whitefish River, Oliver Creek, Corbett Creek, Slate River and Mosquito Creek. These streams will not be described further as little use is made of them.

The Lomond River, or Carp River, as it is locally known, is the natural outlet of the Loch Lomond basin. The discharge from Loch Lomond is regulated by a control dam located at its outlet at the upper part of the Lomond River. The Lomond River has an extremely steep gradient.

The McIntyre River rises near Trout Lake in the highlands north-west of the City of Port Arthur and flows into Thunder Bay within the city. Its gradient is generally quite steep. The entire basin is within the drainage area studied. The water level in the river is about the same as Lake Superior for a distance of several miles from its mouth.

The Neebing River rises in three main branches to the west and north-west of Fort William. They are, the North Branch, the North-West Branch and the South Branch. These branches merge just west of the Lakehead Airport at the "Forks" as it is commonly known. From the forks the river flows in an easterly direction to the CNR bridge in Fort William, and then flows in a north-easterly direction to its mouth, within the City of Port Arthur. The water level in the river is practically the same as Lake Superior for a distance of almost 2 miles from its mouth and shows little change as far as the westerly limit of Fort William, a distance of 4 miles from its outlet.

McVicar Creek and Whiskeyjack Creek drain relatively small areas and discharge directly into Thunder Bay. McVicar Creek rises north-west of the City of Port Arthur and flows in a general south-easterly direction into Thunder Bay. To reduce flood damage and provide better storm drainage, channel improvements have been carried out and more are planned for the lower part of the creek where it meanders through the built-up area of Port Arthur.

Table IV-1 shows the physical characteristics of the major streams and their tributaries in the study area.

<u>Streamflows</u>

Very limited streamflow information is available within the study region. Daily flow data are available for the Kaministikwia River at Kaministikwia and at Kakabeka Falls, about 38 and 28 miles respectively from its mouth. The Neebing River is the only other stream in this region having daily records; however, these records

contain many gaps. Measurement of low summer flow would have to be undertaken on ungauged streams that are of particular interest for either water supply or other uses to determine their adequacy.

The flow gauging stations on the Kaministikwia River and on the Neebing River are operated by the federal Department of Energy, Mines and Resources, Inland Waters Branch. Particulars of these stations are shown in Table IV-2. In addition, the Hydro-Electric Power Commission of Ontario collects flow data on the Kaministikwia River at Kakabeka Falls where the river has a drainage area of 2,610 square miles.

Kaministikwia River

The flow in the Kaministikwia River at Kaministikwia is affected somewhat by the operation of the Silver Falls Hydro-Electric Generating Station about 10 miles upstream. This plant is operated mainly during the day-time in low and average flow periods. Its effect is not considered to be significant at the Kakabeka Falls Generating Station by Ontario Hydro due to the distance and also to the flow from intermediate storage reservoirs on the Shebandowan River, a major tributary which merges with the Kaministikwia River about one-half mile upstream from Kaministikwia. Table IV-3 gives a summary of the flow at gauging station 2 AB-6 at Kaministikwia for the water years 1954-1966.

The flow at Kakabeka Falls is calculated from the amount of water that passes through the turbines at the Kakabeka Falls Hydro-Electric Generating Station and that

spills over the falls. This latter flow is measured at the control dam upstream of Kakabeka Falls using rating curves for the discharge bays and measuring the head of water above the crest of the weirs in the bays. Table IV-4 gives a summary of the calculated flow in the river at Kakabeka Falls for the water years 1957-1966.

The flow at Kakabeka Falls should be larger than the flow recorded at Kaministikwia, since it is 11 miles downstream from the latter and has an additional drainage area of about 114 square miles. Actually the streamflow records indicate that flows at Kakabeka Falls are in most cases considerably less than those recorded at Kaministikwia. The reason for the discrepancy is probably the different methods of measuring the flow. The records of the gauging station at Kaministikwia are perhaps more reliable as actual streamflow measurements are made at intervals for development and maintenance of the rating curve. The records at Kakabeka Falls are indirectly derived values with no values available for seepage at the control dam.

Neebing River

The Neebing River is the only river in the study region that has natural streamflow and for which records are available. Table IV-5 gives a summary of the flow in this river for the water year period 1954-1966.

The annual minimum recorded seven-day average flow of the Neebing River under winter and summer conditions ranged from 0.0 to 11.1 cfs and 0.4 to 7.9 cfs respectively. The annual minimum recorded one-day flow under these conditions ranged from 0.0 to 10.0 cfs and 0.0 to 6.1 cfs respectively.

Minimum Seven-Day Average Flow

Minimum seven-day average flow at a location on a stream within a selected time period is defined as the arithmetic mean of the lowest flows occurring in a period of seven consecutive days. It is an indicator of the dependable flow in a stream.

Tables IV-3, IV-4 and IV-5 show the range of the minimum seven-day average flows for both winter and summer conditions on the Kaministikwia and Neebing Rivers at the gauging stations.

Base Flow or Ground-Water Runoff

The base flow of a stream is that portion of the streamflow that is contributed through the ground and, like surface runoff, is never constant with time; however, its range does not usually vary as widely as the surface runoff. Base flow can be simply referred to as ground-water runoff. Due to the scarcity of streamflow records in this study area and regulation of flow on the Kaministikwia River, it was only possible to arrive at estimates of ground-water runoff for the major part of the Neebing River basin.

From the analyses of annual hydrographs of streamflow as recorded at the gauging station on the Neebing River for the water years ending in 1957, 1958, 1959, 1963 and 1966 it was estimated that the mean annual ground-water runoff varied from about 6 to 16 cfs from a drainage area of 68 square miles. This is equivalent to about 50,000 to 125,000 gpd per square mile. The above years were chosen because they fall in a recent ten-year period of generally

below-normal precipitation and as such would be indicative of ground-water runoff, under adverse climatic conditions.

PRESENT UTILIZATION

In the Lakehead study area both ground and surface waters have been developed for rural domestic use, livestock watering, public, industrial, municipal and recreational uses. Wells and springs are sources from which ground water is derived. Streams, lakes and ponds are sources of surface water. Streams are used also for the dilution and assimilation of liquid wastes and as natural outlets for storm drainage.

In rural areas, streams are used for livestock watering, and recreation. Ground water is the major source for domestic water supplies in these areas.

The estimates of water consumption in this section were derived from population data and estimates, actual pumping and water supply records, or maximum daily takings authorized by water-taking permits when no pumpage records were available and a permit had been issued by the OWRC.

Rural Domestic Water Consumption

The rural population, within the study area, is estimated to be about 12,722 and is scattered throughout the geographic townships with major concentrations in the Townships of McIntyre, Neebing, Oliver and Paipoonge. Water supplies are obtained mainly from ground-water sources through individual dug or drilled wells. The daily per capita consumption probably varies widely, but an average of 50 gallons has been assumed in this report.

Table IV-6 summarizes the estimated rural domestic population as distributed in the townships lying within or partly within the study area and the estimated rural domestic consumption.

Livestock Watering

The estimated quantity of water used for livestock watering purposes in the study area was determined through the use of livestock population data taken from the 1961 Canada Census and the water consumption requirements for different livestock categories as suggested by the Department of Agriculture. Where municipalities or geographic townships used in the Census were not entirely within the study area, the livestock population within the area of study was determined by apportionment. Both ground and surface waters are used for livestock watering. Estimated water consumption from the combined sources is shown in Table IV-7.

Irrigation

Up to June 15, 1967, within the Lakehead study area only one permit had been issued for the purpose of taking water for irrigation. This permit was issued to the Fort William Golf and Country Club which is authorized to withdraw 21,600 gpd from three ponds, created on the head waters of a tributary to Mosquito Creek and 12,000 gpd from a well. Irrigation is supplemental to natural precipitation, and the amounts of water required therefore varies widely.

In 1966, the permittee irrigated during the period May 16 - Sept. 15 for 62 days using a maximum of 17,990 gpd,

a minimum of 7,190 gpd and a mean of 14,650 gpd.

On-Stream Uses

a) Recreation

Recreational use of the streams and lakes consists of boating, fishing, and swimming. There have been no large dams built or permits issued for recreational purposes.

b) Power Production

Two hydro-electric generating stations are in operation in the Lakehead study area. One is located at Kakabeka Falls on the Kaministikwia River and one near the mouth of the Current River at Port Arthur. There is also one thermal-electric generating station at the mouth of the Mission River.

The Kakabeka Falls plant, operated by the Hydro-Electric Power Commission of Ontario has four generating units, three of which have a maximum discharge capacity of 390 cfs each and the fourth 640 cfs for a total of 1,810 cfs. There is a requirement that during the tourist season, June to September, 300 cfs must be discharged over the falls between the hours of 9:00 a.m. and 10:00 p.m. on Saturdays, Sundays and holidays, and 150 cfs must be discharged over the falls between the same hours during week days.

The generating station at the Boulevard Lake Dam on the Current River is owned by the Port Arthur Public Utilities Commission and is operated primarily to meet peak power requirements.

The Thunder Bay Thermal-Electric Generating Station, operated by the Hydro-Electric Power Commission of Ontario, is situated on the north bank of the Mission River at Thunder Bay. This station utilizes cooling water at the rate of approximately 800 cfs.

Advantage is taken of the elevation of Loch Lomond to maintain pressure by gravity in the municipal water distribution system of Fort William.

c) Transportation and Assimilation of Wastes

The McIntyre and Kaministikwia Rivers receive the effluents from the Port Arthur and Fort William water pollution control plants, respectively. The Kaministikwia River also carries the wastes from the industries located on its north shore. Mosquito Creek carries the lagoon effluents from the Fort William Industrial Farm.

Municipal Water Supply

Only two municipal water supply systems are in operation in the Lakehead study area. The City of Fort William obtains its water from Loch Lomond and the City of Port Arthur from Thunder Bay. In this report municipal water usage is subdivided into two categories, industrial water use in excess of 10,000 gpd and other uses. The 1966 municipal consumption is outlined in Table IV-8.

Industrial Water Supply

A large number of industries in the study area are supplied by municipal systems, while others obtain water from private systems using either Thunder Bay or the Kaministikwia River as their source of supply.

Table IV-8 shows the major industrial water takings. Within the study region two permits have been issued for the taking of water for industrial purposes. The permittees are the Great Lakes Paper Company Limited, which is authorized to withdraw 36 mgd from the Kaministikwia River and the Lakehead Co-Operative Abattoir Limited which is allowed to withdraw 10,000 gallons per day from a ground-water source. The former company is situated in the Township of Neebing and the latter is situated in the Township of Oliver.

In 1966 the Great Lakes Paper Company Limited withdrew an average of 22.3 mgd from the Kaministikwia River for the period of operation of its Kraft Mill Water Treatment Plant. Records of this plant commence June 1, 1966. The water takings ranged from 0 to 25.6 mgd during the period June 1, to December 31, 1966. The company withdraws additional water from the same source which is not subject to water taking legislation.

No records of actual takings are available for the Lakehead Co-Operative Abattoir Limited.

Commercial Water Supply

Most commercial establishments are located within urban areas and have access to municipal water systems. No permits have been issued in the region for the withdrawal of water for commercial uses.

Private Water Supply

Several water supply systems are in operation in the study area. Fort William Industrial Farm, situated south of the Kaministikwia River in the Township of Neebing, has

its own drilled wells. In 1966 the Fort William Industrial Farm withdrew an average of 13,000 gpd from this source.

Two water supply systems are in operation at the Kakabeka Falls Provincial Park, one serving a camp site and picnic area called the Campsite System and the other serving the public washrooms, observation tower and restaurant called the Greenmantle System. The first system uses spring water while the second obtains water from a shallow well. No consumption figures are available.

Another communal water system serves eight houses and the plant at the Trans Canada Pipeline Compressor Station No. 68 in the Township of MacGregor. Consumption is estimated to be 2000-3000 imperial gallons per day. The source of supply is shallow, dug wells.

POTENTIAL FOR FUTURE DEVELOPMENT

Ground Water

The amount of ground water available for extraction from wells is estimated to be in the range of 6 to 12 million gallons per day. It appears, however, that only small amounts of water are available at any single location.

It is unlikely that high capacity municipal wells can be located in bedrock formations because of the poor aquifer characteristics of the bedrock. Wells in the overburden capable of yielding sufficient ground water for communities of about 100 persons may be feasible in some areas; however, extensive test drilling would probably be required to locate suitable aquifers.

It appears likely that withdrawals of ground water in the study region will remain limited mainly to low capacity wells for domestic consumption.

Surface Water

The flow in the rivers in this region, except in the Kaministikwia River, varies widely with high flows in the spring and during storms, and very low summer flows. The range of minimum seven-day average flows in the Neebing River as presented in Table IV-5 gives a fair indication of the small minimum flows available in the Townships of Oliver, McIntyre, Paipoonge and Neebing. These flows could be increased through the construction and operation of storage reservoirs to catch and store part of the high flows carried by the streams during the spring freshet period. The Kaministikwia River, a present source of industrial water supply, has potential for further development. Thunder Bay, the water source for Port Arthur provides a virtually unlimited source of water supply. The economics of supply rather than the quantity of water available will determine the areas in the study region which it will ultimately serve.

Loch Lomond

Loch Lomond, the present source of water for Fort William, is located about 6 miles south of the City. It is surrounded by large hills some of which rise to an elevation of over 1,500 feet. The lake itself has a maximum water level of about 938 feet which is more than 330 feet above Lake Superior. It has a surface area of 6.3 square miles and a land drainage area of 23.9 square miles. Under natural conditions, the lake

would discharge through the Lomond River, locally known as the Carp River, to Lake Superior.

The City of Fort William has utilized Loch Lomond as its source of water supply since 1909. Works constructed on this lake include a control dam on the Lomond River to regulate the natural discharge from the lake, an intake structure in the lake and a gravity pipeline system.

The lake level can be drawn down to 12 feet below the top of the control dam without seriously affecting the operation of the water works system; however, this condition has never been reached. The greatest drawdown occurred during 1914-1916 when the water level lowered 3 feet.

Insufficient hydrometric data are available to calculate accurately the yield of the Loch Lomond drainage basin. Precipitation records have not been collected within the basin and no recent records of the discharge through the control dam at the Lomond River are available. Records of the water takings for the water supply system and of the water level of Loch Lomond are available. Figure IV-2 shows the maximum and minimum monthly water levels for the period 1957 to 1966 inclusive.

In order to arrive at an estimate of evaporation and evapotranspiration, it was assumed that the meteorological records collected at the Lakehead Airport are applicable to the Loch Lomond basin, even though the airport lies at least 280 feet below Loch Lomond.

Table IV-9 shows the annual precipitation at

Lakehead Airport and the estimates of evaporation and evapotranspiration used in the annual, long, and short-term recharge calculations for the Loch Lomond Basin.

These evapotranspiration estimates have been carefully checked with water balance studies in nearby basins and evaporation estimates have been compared with those in the literature.

From a contour map of Loch Lomond, having a scale 1 inch = 1,320 feet and showing depth contours at 60-foot intervals, the areas of the lake surface and at the 60-foot depth were determined. Unfortunately this map does not show the reference elevation to which the contours are referred. It has been assumed in this study that the maximum allowable height of the control dam is the reference which lies 937.91 feet above sea level. The areas from the surface to the 12-foot depth and the volumes for the upper 4 feet and for the upper 12 feet were obtained through interpolation. The volumes of water stored from 0 to 4 feet and 0 to 12 feet below the top of the dam are respectively 665 and 1,867 million cubic feet. The latter value refers to the maximum volume that can be manipulated under existing conditions.

The potential recharge values of Loch Lomond listed in Table IV-10 were based upon the difference between the precipitation and the evaporation and evapotranspiration estimates shown in Table IV-9. The lake surface area used in the calculations was held constant at that of the 937.25-foot elevation. The potential recharge refers to the recharge potential of the drainage basin and does not take into account the storage available to hold this recharge.

For comparison purposes Table IV-10 shows also the Fort William municipal water takings from Loch Lomond.

It is apparent that greater use can be made of Loch Lomond when required through different operating procedures whereby the lake will have to be drawn down to lower-than-present levels. This would, however, result in wider water-level fluctuations. During the 10-year period 1957-1966, which was generally a time of below normal precipitation, the potential mean annual recharge was 695 million cubic feet. The potential mean annual recharge for the 30-year period 1931-1960 was estimated to be 919 million cubic feet.

The variation of potential recharge is a function of the climatic fluctuations such as temperature and precipitation. The period of 1957-1966 was generally a period of below normal precipitation. During 8 of the 10 years precipitation was below the long-term annual mean of 29.4 inches.

It can be concluded from the data available and its analysis that Loch Lomond would likely be able to sustain a mean annual water taking of about 700 million cubic feet or 4,350 million gallons. This recharge amounts to one and one-half times the 1966 Fort William municipal water consumption. If this source is to be used in the future, a thorough study of the Loch Lomond drainage basin should be conducted to assess its potential fully. Discharge records for the Lomond River and accurate meteorological data for the Loch will be required for such a study.

TABLE IV-1

PHYSICAL CHARACTERISTICS OF THE MAJOR STREAMS AND THEIR TRIBUTARIES

Stream Tributary	Length Miles	Gradient ft./mi.	Drainage Area square miles
Current River	-	-	265
a) Onion Lake Dam to mouth	16.2	37	122
North Current River	21.3	35	-
Kaministikwia River	-	-	3,020
a) Dog Lake to Kaministikwia (above study area)	16.9	20	-
b) Kamistikwia to Kakabeka Falls	11.0	16	-
c) Kakabeka Falls to mouth	27.8	5	-
Oliver Creek	9.5	54	20
Corbett Creek	17.4	40	29
Slate River	25.5	24	72
Mosquito Creek	4.4	43	12
Lomond River	1.9	184	33
McIntyre River	26.0	37	64
McVicar Creek	9.0	58	20
Neebing River	18.9	38.2	85
North Branch	4.4	66.4	-
North-West Branch	8.8	45.1	-
South Branch	9.4	25.5	-
Whiskeyjack Creek	3.6	100	3

The data in this table were mainly taken from topographic maps, some provisional, at a scale of 1:50,000. The only exceptions were the data for the Neebing River which were taken from the Neebing Valley Conservation Report 1957. The gradients and drainage areas of all streams were determined to the nearest whole number except for the gradients of the Neebing River and its branches.

TABLE IV-2

PARTICULARS OF STREAMFLOW GAUGING STATIONS

Gauging Station Number	Location	Drainage Area (sq.mi.)	Present Type of Gauge	Periods of Records and Remarks
2 AB-6	Kaministikwia River at Kaministikwia	2,500	Recording	Nov.'25 to date (flow affected by regulation)
2 AB-8 formerly 2 AB-7	Neebing River near Fort William	68	Recording (manual during ice-cover periods)	Continuous Streamflow Records Aug.'53-Oct.'59 Oct.'62-Sept.'63 Apr.'65 to date Streamflow Records mainly during open water periods May '60-May '62 Apr.'64-Oct.'64

TABLE IV-3

STREAMFLOW IN KAMINISTIKWIA RIVER AT GAUGING STATION 2AB-6 AT KAMINISTIKWIA

AND PRECIPITATION AT KAKABEKA FALLS

Drainage Area - 2500 square miles

WATER YEAR	MEAN MONTHLY AND ANNUAL STREAMFLOW (CFS) OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	YEAR	ANNUAL PRECIPITATION KAKABEKA FALLS in inches
1953 - 1954	1740	1700	1710	1730	1840	1770	2630	7960	5310	2060	1610	1510	2640	26.38
1954 - 1955	1440	1450	1260	1190	1200	1280	2480	1460	1180	1250	1130	1370	1390	24.84
1955 - 1956	1560	1620	2200	1880	1900	1350	1780	3640	2410	1680	1310	1460	1900	28.43
1956 - 1957	1200	1380	1430	1670	1560	1470	3200	2350	2680	2890	1310	1390	1880	24.27
1957 - 1958	1360	1550	1490	1530	1570	1470	1420	1110	1420	1610	1670	1370	1460	20.31
1958 - 1959	1430	1310	2550	1910	2410	1730	1590	1550	2240	1670	1780	1980	1840	27.49
1959 - 1960	2200	1980	1820	2820	1880	1590	2700	1550	1140	1540	1320	1100	1800	23.73
1960 - 1961	1080	1530	1330	1500	2200	2260	2300	1790	1710	1530	1920	3370	1870	29.32
1961 - 1962	2240	2310	1870	1790	2020	2440	2410	2240	2890	1800	3560	2040	2300	27.25
1962 - 1963	1530	1830	1700	1520	1450	1510	1650	1860	8400	1790	1710	1960	2240	22.69
1963 - 1964	885	1310	1770	1440	1450	1820	2590	4520	7780	4550	1310	2600	2670	29.92
1964 - 1965	2750	2470	2130	2090	2270	2320	2900	3560	2290	1440	1760	2020	2330	28.26
1965 - 1966	3350	1890	2280	4220	3010	2530	4100	5980	3070	1410	1200	958	2840	23.68
Period Mean 1954 - 1966	1700	1720	1810	1950	1900	1810	2440	3040	3270	1940	1660	1780	2090	25.89
Period Mean 1957 - 1966	1800	1760	1840	2050	1980	1910	2490	2650	3360	2020	1750	1880	2120	25.69

Period of Record	MINIMUM SEVEN-DAY AVERAGE FLOW (CFS) Winter Conditions Max.	Mean	Min.	Summer Conditions Max.	Mean	Min.	MINIMUM ONE-DAY FLOW (CFS) Winter Conditions Max.	Mean	Min.	Summer Conditions Max.	Mean	Min.
1954 - 1966	1810	1370	1080	1530	997	503	1650	935	220	1030	583	226

TABLE IV-4

STREAMFLOW IN KAMINISTIKWIA RIVER AT KAKABEKA FALLS GENERATING STATION

MEAN MONTHLY AND ANNUAL STREAMFLOW (CFS)

WATER YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	YEAR
1956 - 1957	1097	1205	1399	1412	1382	1406	3271	2061	2382	2475	1210	1286	1714
1957 - 1958	1387	1525	1511	1571	1575	1461	1463	989	1286	1494	1518	1167	1411
1958 - 1959	1219	1086	927	1405	1964	1896	1485	1503	1988	1484	1502	1734	1512
1959 - 1960	2053	1607	1563	1873	1787	1624	2767	1652	1229	1432	1289	1033	1658
1960 - 1961	977	1387	1219	1698	1966	1913	2252	1668	1518	1407	1593	3272	1734
1961 - 1962	2010	2030	1510	1490	1680	2100	2200	2050	2380	1600	3000	1680	1979
1962 - 1963	1260	1560	1480	1350	1290	1360	1670	1710	7250	1510	1400	1650	1951
1963 - 1964	800	1170	1530	1280	1290	1600	2430	3990	6920	3880	960	2230	2339
1964 - 1965	2480	2180	1880	1790	1960	1940	2890	3920	2330	1250	1400	1860	2156
1965 - 1966	2960	1650	1830	2050	2110	2220	4300	6390	3100	1260	960	860	2477
Period Mean 1957 - 1966	1624	1540	1485	1592	1700	1752	2473	2593	3038	1779	1483	1677	1893

	MINIMUM SEVEN-DAY AVERAGE FLOW (CFS)						MINIMUM ONE-DAY FLOW (CFS)					
	Winter Conditions			Summer Conditions			Winter Conditions			Summer Conditions		
Period of Record	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.
1957 - 1966	1573	1273	813	1250	786	519	1180	839	520	890	362	10

NOTE: Drainage Area - 2610 square miles

TABLE IV-5

STREAMFLOW IN NEEBING RIVER AT GAUGING STATION 2AB-8 NEAR FORT WILLIAM

AND PRECIPITATION AT LAKEHEAD AIRPORT

NOTE: Drainage Area - 68 square miles

	MEAN MONTHLY AND ANNUAL STREAMFLOW (CFS)													ANNUAL PRECIPITATION LAKEHEAD AIRPORT
WATER YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	YEAR	in inches
1953 - 1954	11	11	11	3.4	4.3	7.4	270	314	64	3.2	2.3	4.3	59	30.06
1954 - 1955	7.6	11	5.2	3.4	3.0	3.8	229	57	7.9	3.0	3.3	11	29	30.19
1955 - 1956	43.0	90	27.9	16.5	12.4	19.2	371	204	48.8	33.8	6.0	9.5	73	36.92
1956 - 1957	4.6	24.9	12.8	7.5	1.9	22.0	367	92	53	19.9	9.4	4.8	51	26.77
1957 - 1958	11.5	20.4	3.1	1.0	1.3	10.9	64	34.3	32.2	9.5	4.3	22.4	17.9	24.03
1958 - 1959	36.6	49.6	21.9	5.0	2.2	12.8	100	136	53	8.3	14.9	35.3	39.8	31.61
1959 - 1960	63	-	-	-	-	-	-	115	28.8	5.3	9.5	5.4	-	23.27
1960 - 1961	158	56.8	-	-	-	-	162	89.1	23.2	35.8	9.4	59.0	-	26.50
1961 - 1962	66.2	75.4	-	-	-	-	165	152	-	-	-	-	-	25.85
1962 - 1963	18.6	19.9	12.5	4.0	0.0	5.2	110	62.2	154	12.3	11.1	23.5	35.9	21.99
1963 - 1964	-	-	-	-	-	-	269	282	128	30.3	16.4	17.3	-	28.83
1964 - 1965	35.1	-	-	-	-	-	345	238	34.2	11.8	9.7	72.3	-	28.39
1965 - 1966	137	27.3	26.5	14.2	37.3	67.6	425	165	32.4	4.5	5.8	4.2	78.7	23.31
MEAN MONTHLY AND ANNUAL FLOW														
Mean of water years 1954-1959, 1963 & 1966	33.7	31.8	15.1	6.9	7.8	18.6	242	133	55.7	11.8	7.1	14.4	48	

	MINIMUM RECORDED SEVEN-DAY AVERAGE FLOW						MINIMUM RECORDED ONE-DAY FLOW					
	Winter Conditions			Summer Conditions			Winter Conditions			Summer Conditions		
Period of Record	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.
1954 - 1966	11.1	-	0.0	7.9	-	0.4	10.0	-	0.0	6.1	-	0.0

TABLE IV-6

ESTIMATED RURAL POPULATION AND WATER CONSUMPTION

Geographic Township	Permanent Population	Year of Record	Water Consumption at 50 gpcd
Jacques[a]	10	1961	500
Ware[a]	148	1961	7,400
Gorham[b]	529	1966	26,450
MacGregor[a]	56	1961	2,800
Oliver[b]	1,240	1966	62,000
McIntyre[c]	4,664	1966	233,200
Paipoonge[b]	2,211	1966	110,550
Neebing	3,500	1967	175,000
Scoble[d]	90		4,500
Gillies[a]	16	1966	800
Pearson[d]	40		2,000
Blake[c]	170	1966	8,500
O'Connor[a]	48	1966	2,400
TOTAL	12,722		636,100 gpd

a Population in those geographic townships lying partly within study area has been estimated on proportion of homes inside and outside study area when total population was given in Canada Census.

b Canada Census

c Assessor's figures

d Population figures for these townships were not available; however, population estimates were made based upon the number of homes shown on topographic maps covering those parts of the townships lying within the study area and assuming a density of 3.5 persons per home.

TABLE IV-7

ESTIMATED LIVESTOCK WATER CONSUMPTION

		Water Consumption (mgd)
Municipality of Neebing*		
Neebing and Blake		.024
Municipality of Shuniah*		
McIntyre and MacGregor		.030
Township of Oliver		.042
Township of Paipoonge		.080
Geographic Townships		
Gorham		.010
Scoble		.001
	TOTAL	.187

* Only the geographic townships within the municipality lying wholly or partially within the study area have been tabulated.

TABLE IV-8

ESTIMATED TOTAL MUNICIPAL WATER USE AND MAJOR INDUSTRIAL WATER USE

FROM MUNICIPAL AND PRIVATE SOURCES

Municipality	Total Takings by Municipal Water Supply System (mgd)	Source of Municipal Taking	MAJOR INDUSTRIAL WATER TAKINGS[a] from Municipal Water Supply System (mgd)	from Private Water Supply Systems (mgd)	Source of Private Industrial Takings
Fort William	7.76	Loch Lomond	2.15	11.00	Thunder Bay
				80.00	Mission River
Port Arthur	5.93	Thunder Bay	0.43	33.39	Thunder Bay
Neebing					
Neebing Twp.	-	-	1.03[b]	67.30[c]	Kaministikwia R.
Oliver	-	-	-	0.01	ground water

NOTES: - water use based on 1966 data

a Individual industrial takings equal to or larger than 10,000 gpd.
b Water obtained from Fort William water supply system.
c This value is partially based on 1967 data.

TABLE IV-9

ANNUAL AND MEAN ANNUAL PRECIPITATION AT LAKEHEAD AIRPORT

AND

ESTIMATED ANNUAL AND MEAN ANNUAL EVAPORATION FROM LOCH LOMOND

AND EVAPOTRANSPIRATION FROM LOCH LOMOND BASIN

Year	Annual Precipitation at Lakehead Airport (inches)	Evaporation from lake area (inches)	Evapotranspiration from land area (inches)
1966	22.8	24.7	13.2
1965	30.8	23.9	13.4
1964	30.3	24.0	14.1
Term Mean			
1930 - 1960	29.4	24.1	14.3
1957 - 1966	25.9	24.4	13.8

TABLE IV-10

ESTIMATED ANNUAL POTENTIAL RECHARGE OF LOCH LOMOND

AND ANNUAL FORT WILLIAM MUNICIPAL WATER TAKINGS

FROM LOCH LOMOND

Period	Potential Recharge million cu. ft.	Potential Recharge million gallons	Fort William Municipal Water Takings million cu. ft.	Fort William Municipal Water Takings million gallons
1964	994	6190	405	2525
1965	1070	6660	422	2626
1966	509	3170	455	2834
1957 - 1966	695	4340	-	-
1931 - 1960	919	5720	-	-

V

WATER SUPPLY

EXISTING FACILITIES

There are a total of six communal water works systems in the study region. Only two of these are municipally operated. The other four are private systems serving limited areas and therefore are of little significance to this study. Table V-1 lists the existing facilities itemizing the source, nominal capacity, treatment provided, available storage and number of services for each system at the end of 1967. Further details on the two main systems are provided below.

Fort William

A comparison of the theoretical and reported capacities of the supply works is as follows. The reported capacities were supplied by staff of the Water Works Department.

Item	Calculated Capacity	Reported Capacity
Intake	33.4 mgd	32 mgd
Tunnel	54.3 mgd	54 mgd
Pipelines from tunnel to reservoir	16.8 mgd	16 mgd
Pipelines from reservoir to city	27.1 mgd	26 mgd

It is noted that these figures agree closely and the limiting capacity of the physical works therefore appears to be about 16 mgd. As noted in Section IV, the source is estimated to be capable of a perennial yield of only about 12 mgd. This will be discussed in greater detail later in the report.

There is a question of the vulnerability of the supply works. The three pipelines from the tunnel to the reservoir and from the reservoir to the city are placed adjacent to each other. A possibility therefore exists that if a major break occurs in one line, the other two could be damaged. Two of the lines from the tunnel are more than 50 years old and two of the lines from the reservoir to the city are more than 40 years old. Reportedly the old lines are in good condition and should provide many more years of service. The present system is limited to a maximum of about 16.8 mgd (0.773 mg storage) without pumping from the fore-bay or building an additional pipeline from the fore-bay to the reservoir. This system's peak capacity can economically be increased by providing additional storage at the present reservoir site.

Port Arthur

The intakes into Lake Superior should be able to deliver approximately 20 mgd. The exact capacity of the intakes could be confirmed by a drawdown pumping test. The two 24-inch diameter mains from the pumping station to the city are more than 55 years old. To maintain adequate distribution system pressures, these lines must be limited to a capacity of about 9 mgd. The only practical way of increasing the capacity is to build a third line to the city. Pumping ability at the plant is no particular problem since it can be readily increased.

Consumption

The water consumption figures for the two cities and the Industrial Farm for 1963 to 1967 are shown in Table V-2.

A comparison of Tables V-1 and V-2 indicates that the Port Arthur supply works capacity is approached on maximum days while the Fort William system source is exceeded on maximum days. Similarly, a comparison of assessed populations with the average water consumption will reveal a per capita usage of 119 and 155 gallons per day in 1967 for Port Arthur and Fort William respectively. A closer look at the large industrial consumers for both systems reveals a daily usage of approximately 685,000 and 2,300,000 gallons for Port Arthur and Fort William respectively. Reducing the total consumptions by these amounts and then dividing by the population served produces more realistic per capita consumptions of 105 and 107 gallons per day for Port Arthur and Fort William respectively.

GENERAL CONSIDERATIONS

Quantity

In Section IV, the water resources of the region were explored and evaluated. It was concluded that Lake Superior provided an unlimited source of supply, the Kaministikwia River had sufficient flow for municipal purposes and the perennial yield available from Loch Lomond was estimated to be limited to about 12 mgd. Ground-water sources are more restricted with supplies for municipal purposes only available from the overburden at scattered locations with extensive test drilling required to determine the extent of the supply; however, well supplies for individual purposes generally can be obtained throughout the region.

Quality

The chemical quality of the water from the existing

water works is summarized in Table V-3. It can be seen that the waters from Lake Superior and Loch Lomond are very similar in chemical quality and are suitable for domestic water supplies. The average turbidity and phenol concentrations in the raw water at the Port Arthur water works exceed the OWRC Drinking Water Objectives. However only a total of 25 samples were evaluated. A more intensive monitoring programme would confirm the validity of these results and provide better information upon which to decide whether additional treatment facilities are required.

A Biological Survey of the Kaministikwia River and Thunder Bay was completed during 1965 and 1966 and copies of the report were forwarded to the municipalities and interested parties in the study area on August 29, 1967. This survey revealed that the water quality of the Kaministikwia River was unimpaired above the discharge from the Great Lakes Paper Company. Below this point, water quality was seriously impaired as a result of industrial and domestic wastes. In Thunder Bay, localized areas of organically contaminated water occurred near the mouth of the Kaministikwia River, within the Lakehead Harbour, and in the vicinity of the waste discharges from the Abitibi Paper Company's Thunder Bay Division. Additional data on surface water quality is included in Section VI.

DESIGN CRITERIA

The estimated future population and the area that it will probably occupy were outlined in Section III. For design purposes, it has been assumed that all of the

population estimated for the two cities will be supplied by the municipal systems. In addition, the following usages were assumed for the Municipalities of Neebing and Shuniah.

Year	MUNICIPALITY OF NEEBING Est. Pop.	Percent Served	Pop. Served	MUNICIPALITY OF SHUNIAH Est. Pop.	Percent Served	Pop. Served
1978	4,600	75	3,450	7,600	50	3,800
1988	5,300	90	4,760	8,600	75	6,450
Ult.	7,200	90	6,500	9,900	90	8,900

As mentioned earlier, when the large industrial users are deducted from the total consumption, the current per capita water consumption is reduced to approximately 107 gpd. With the modern inovations which continually occur in the home and industry, it is reasonable to expect that the per capita demand will increase steadily in the future. As a result, the average per capita demand was increased at the rate of one-half gallon per year from a base of 107 gpcd in 1967. This results in the following average per capita demands:

1978	-	112.5 gpcd
1988	-	117.5 gpcd
Ultimate	-	132.5 gpcd

These figures include domestic, commercial and small industrial usages. In addition, the large industrial usage for Fort William and Port Arthur was estimated to increase at the rate of five (5) per cent per year until 1988 and one (1) per cent per year thereafter; however, an overriding maximum of 3 mgd was applied to both systems.

Maximum day domestic demands were based on the following criteria:

Population Served	Maximum Day
3,000 - 10,000	2.00 times average day
10,000 - 25,000	1.90 times average day
25,000 - 50,000	1.80 times average day
50,000 - 75,000	1.75 times average day
75,000 - 150,000	1.65 times average day
more than 150,000	1.50 times average day

Individual storage requirements were calculated using the criteria shown below:

A. Fire Storage - In accordance with the "Standard of Municipal Fire Protection" prepared by the Canadian Underwriters' Association.

B. Equalizing or Operating Storage - 25 per cent of the calculated maximum day flow.

C. Emergency Storage - 25 per cent of the total storage volume.

Hazen-Williams "C" factors of 130 for new cast iron pipe with decreasing values based on pipe age and reported condition have been used. Allowable friction losses of up to 5 feet per 1000 feet have been considered for pipe sizes of up to 24-inch diameter where distribution system characteristics permitted. Federal Department of National Defense 1:50,000 topographical maps have been used for the region, with 1:4,800 topographical maps produced for the Lakehead Planning Board utilized in the urban area.

SOURCE OF FUTURE SUPPLIES

From the data presented in Section IV, it is obvious that the future water supplies for the Fort William-Port Arthur urban area must be obtained from surface sources. Similarly, as previously discussed there are only three alternatives, namely, the Kaministikwia River, Loch Lomond and Lake Superior (Thunder Bay). It was concluded that

the Kaministikwia River should not be considered since complete treatment facilities would be required. The detailed work on the water supply has been restricted to supplying the Lakehead urban area with water from Loch Lomond and/or Lake Superior. The raw water quality at the Port Arthur Water Works should be monitored closely in the future to assess if and when additional treatment may be required.

WATER SUPPLY ALTERNATIVES

There are three possible alternatives for supplying water to the Fort William-Port Arthur area. These are; a separate supply and distribution system for each municipality; two supply and distribution systems, with one serving the Fort William-Neebing area and the other serving the Port Arthur-Shuniah area; a totally combined system serving the entire urban area. These systems are discussed in greater detail following.

Separate Systems

The only apparent advantage to this alternative is the preservation of local autonomy in the control of water service. There are numerous disadvantages. The Municipalities of Neebing and Shuniah are isolated from their best source of supply (Lake Superior) by existing urban areas. Long costly supply mains would be required either through the existing urban areas or routed around the existing development through largely uninhabited lands. The City of Fort William will require an additional source of supply in about 20 years together with new feeder mains. The intakes for the Port Arthur system have sufficient capacity for the future needs of the city with some surplus capacity remaining. New feeder mains will also be required

in the distribution system. If the two systems remain separate therefore, and two new systems are developed in Neebing and Shuniah a great amount of duplication will result. In addition the total storage requirements for four separate systems would be larger than for a fewer number of combined systems. Peaks in demand both for instantaneous flow and maximum day flow would also be greater in proportion to the average day flow for separate systems.

Partially Combined Systems

A solution providing two supply and distribution systems with one to serve Fort William-Neebing and the other to serve Port Arthur-Shuniah is better than four separate systems. This would permit some reduction in storage requirements and eliminate the necessity for Neebing and Shuniah to build mains through another municipality. It does not however solve all of the problems. The Fort William-Neebing system would still have to establish an alternate source by shortly after 1988. This would probably be obtained from Lake Superior at Grand Point and would require an intake extending about 3,200 feet to a water depth of 50 feet, a pumping station and approximately 27,000 feet of feeder main connected to the junction of the two existing 24-inch and the two existing 18-inch diameter mains on the south side of the Kaministikwia River would also be required. The Port Arthur-Shuniah system would have to be immediately reinforced in the southern part with mains leading back to the plant. This area is much closer to adequate supply from the Loch Lomond system than it is from the Bare Point system, although reserve intake capacity is available at Bare Point.

Totally Combined System

A total integration of the two existing water supply and distribution systems would provide numerous advantages. Construction of extensions to the systems could be staged to provide the best service to an area from whichever system could supply it. There would be no necessity to construct a new intake and pumping station at Lake Superior with connecting mains to the existing systems in the foreseeable future. Improved pressures can be provided to the inter-city and university areas in a very short time. The existing supply works can be utilized to optimum conditions with minor improvements. The large industrial demand presently existing in Fort William would become a factor of lessened importance in an integrated system. Total storage requirements would be lowered and the peak factor for maximum consumption days would probably be lessened. Perhaps the most important factor would be the flexibility of operation and lowered probability of emergency shut-down provided by a system with two sources of supply, one at either extremity of the urban area.

PROPOSED WORKS

As a result of the aforementioned possibilities, investigations were undertaken to determine the supply and distribution needs and the most practical means of meeting these. There are a number of shortcomings in the existing systems. Both are deficient in storage based on the requirements previously outlined. There is presently a need for water service in the area north-west of and adjacent to Port Arthur known locally as Jumbo Gardens. The delivery of adequate quantities of water at desired pressure to the extreme southern portion of Port Arthur

may become difficult. The north-western area of the Fort William feeder system should be reinforced with a large diameter main joining the existing system near the junction of Yonge and Frederica Streets. In addition, the problem of providing service to the future growth areas west of Port Arthur and Fort William requires consideration when constructing any new feeder mains.

The large storage available in Loch Lomond should be utilized to its fullest. To do this, more accurate information is required. This can be accomplished by providing a streamflow gauging station at the natural outlet of Loch Lomond, and a meteorological station within the basin. Data from these sources together with those from snow surveys would permit better management of the Loch Lomond water resource. As shown in Section IV, the top 12 feet of water in the Loch is equivalent to about 11.5 billion gallons of water. This reserve could be used to operate the system at its physical limit (16.8 mgd) for more than six years under average climatic conditions or 4.8 mgd more than average basin yield. This flexibility could postpone the time when an additional supply main to Bare Point must be built if better data were available and good water management practices were employed.

To utilize the advantages of a totally integrated system the feeder mains, reservoirs and pumping stations shown in Figure V-1 should be constructed during the 20-year design period. A possible priority listing of the suggested works is given below:

A. Extend existing 24-inch diameter feeder main from vicinity of Madeline Street and McVicar Creek in Port Arthur to intersect with existing 12-inch diameter main on Red River Road.

B. Extend existing 12-inch diameter main on Red River Road and Dawson Road from Carl Avenue to Reservoir 1.

C. Construct Reservoir 1 (2.0 mg) and pumping station on Dawson Road.

D. Construct 6.0 mg extension to existing Fort William reservoir.

E. Construct feeder main on James Street from Montreal Street north to existing Fort William boundary.

F. Construct feeder main on existing city boundary from Jones Street east to Edward Street.

G. Construct feeder main from Edward Street at Fort William north boundary, northward to Oliver Road (II).

H. Construct feeder main from Oliver Road (II) westward to Reservoir 2.

I. Construct Reservoir 2 (1 mg).

J. Construct feeder main from Red River Road south-west and south to Oliver Road (II).

K. Construct additional feeder main from Bare Point Pumping Station to Lyon Boulevard.

L. Replace existing 2.0 mgd pump at Bare Point Pumping Station with new 6.0 mgd pump.

M. Replace existing 1.0 mgd pump at Chamberlain Street Booster Station with new 3.0 mgd pump with standby power.

N. Extend Reservoir 2 from 1.0 mg to 4.0 mg.

These works should provide an adequate water feeder system to the large urbanizing area in and around Port Arthur-Fort William based on the total populations and area shown in Section III. Local supply mains from these works will have to be constructed as required.

For those communities such as Kakabeka Falls, Murillo, and Rosslyn which are considerably removed from the present and projected urban service area around Fort William-Port Arthur, the provision of communal water systems may present problems. Ground-water supplies appear to be limited to quantities capable of supporting only individual,

or at most several homes. In general, surface supplies from rivers are relatively expensive for communities of this size. Therefore it would appear to be reasonable to limit development to less than 1000 persons in each community and permit building only on lots of at least one acre in size. This lot size should permit the installation and prolonged satisfactory operation of individual services provided soil characteristics are suitable.

TABLE V-1

SUMMARY OF WATER SUPPLY FACILITIES (1967)

Municipality	Source	Nominal Capacity	Treatment Provided	Storage	No. of Services
City of Fort William	Loch Lomond	16 mgd(1)	Screening, Chlorination	0.773 mg (Elevated Ground)	14,487(2)
City of Port Arthur	Lake Superior	9.5 mgd(3)	Screening, Chlorination	2.0 mg (Ground), 1.8 mg (Ground - Under Construction), 0.2 mg (Standpipe)	12,215
Township of MacGregor Trans-Canada Pipelines Ltd. Compressor Station No.68	2 dug wells	N.A.	Chlorination	N.A.	9
Township of Neebing Fort William Industrial Farm(4)	2 drilled wells	16,000 gpd	Chlorination	40,000 gal. (Ground)	N.A.
Township of Oliver Kakabeka Falls Provincial Park					
1) Campsite System	springs	N.A.	Chlorination	None	N.A.
2) Greenmantle System	well	N.A.	Chlorination	None	N.A.

NOTES:
(1) Limiting capacity of existing supply works (Pipelines from tunnel to reservoir). Source estimated yield of approximately 12 mgd.
(2) Includes 28 services in Municipality of Neebing.
(3) Pumping capacity with largest pump out of service. Pipelines from plant to built-up area limited to to approximately 9 mgd to provide sufficient distribution system pressure at extremity.
(4) Obtaining alternate source from City of Fort William via Municipality of Neebing distribution system.

TABLE V-2

WATER CONSUMPTION

	City of Fort William			City of Port Arthur			Fort William Industrial Farm		
Year	Total (mg)	Max. Day (mgd)	Avg. Day (mgd)	Total (mg)	Max. Day (mgd)	Avg. Day (mgd)	Total (mg)	Max. Day (mgd)	Avg. Day (mgd)
1963	N.A.	N.A.	N.A.	1,656	7.010	4.587	N.A.	N.A.	N.A.
1964	2,525	N.A.	6.917	1,916	8.373	5.235	4.490	N.A.	0.012
1965	2,626	8.043*	7.200	2,085	8.174	5.712	4.039	N.A.	0.011
1966	2,834	8.655*	7.764	2,164	9.393	5.929	4.750	N.A.	0.013
1967	2,725	12.896	7.467	2,039	8.568	5.588	4.159**	0.018**	0.013**

* - average day during maximum week

** - for January 1 to November 22, 1967 period only (326 days)

TABLE V-3

POTABLE WATER QUALITY

	City of Fort William	City of Port Arthur	Fort William Industrial Farm (Neebing Township)
Hardness as $CaCO_3$ (ppm)			
Average	30	49	288
Maximum	50	58	302
Minimum	14	42	252
No. of Samples	80	28	6
Alkalinity as $CaCO_3$ (ppm)			
Average	21	45	303
Maximum	50	63	316
Minimum	16	22	297
No. of Samples	80	28	6
Iron as Fe (ppm)			
Average	0.14	0.22	0.30
Maximum	0.50	1.25	0.43
Minimum	0.00	0.04	0.16
No. of Samples	80	28	6
Chloride as Cl (ppm)			
Average	3	2	4
Maximum	32	7	5
Minimum	0	0	2
No. of Samples	80	27	6
pH at OWRC Lab.			
Average	7.5	7.8	8.0
Maximum	8.6	8.2	8.3
Minimum	6.5	7.4	7.8
No. of Samples	80	28	6
Fluoride as F (ppm)			
Average	0.2	0.2	0.3
Maximum	0.3	-	0.3
Minimum	0.1	-	0.2
No. of Samples	6	1	5
Apparent Colour Units			
Average	10	< 5	< 5
Maximum	35	15	< 5
Minimum	< 5	< 5	< 5
No. of Samples	64	24	2
Turbidity Units			
Average	1.6	6.2	2.6
Maximum	21.0	56.0	2.6
Minimum	0.1	0.6	2.6
No. of Samples	63	25	2

TABLE V-3
(Cont'd)

POTABLE WATER QUALITY

	City of Fort William	City of Port Arthur	Fort William Industrial Farm (Neebing Township)
Calcium as Ca (ppm)			
Average		15	
Maximum		40	
Minimum		13	
No. of Samples		24	
Total Solids (ppm)			
Average		88	
Maximum		386	
Minimum		16	
No. of Samples		23	
Sulphate as SO_4 (ppm)			
Average		6	
Maximum		24	
Minimum		1	
No. of Samples		21	
Phenols (ppb)			
Average		3	
Maximum		8	
Minimum		0	
No. of Samples		22	

TABLE V-4

FUTURE MUNICIPAL WATER DEMAND

1978

Municipality	Population	Population Served	Max.Day (mgd)	Avg.Day (mgd)	Storage Required (mg)
Separate Systems					
Fort William(1)	59,000	59,000	14.61	9.64	11.04
Neebing	4,600	3,450	0.78	0.39	1.16
Port Arthur(2)	58,100	58,100	12.42	7.54	8.31
Shuniah	7,600	3,800	0.86	0.43	1.21
TOTAL	129,300	124,350	28.67	18.00	21.72
Combined as one System	129,300	124,350	27.10	18.00	14.86

1988

Municipality	Population	Population Served	Max.Day (mgd)	Avg.Day (mgd)	Storage Required (mg)
Separate Systems					
Fort William(1)	68,700	68,700	17.12	11.07	10.44
Neebing	5,300	4,760	1.12	0.56	1.56
Port Arthur(2)	68,500	68,500	15.71	9.67	9.66
Shuniah	8,600	6,450	1.52	0.76	2.09
TOTAL	151,100	148,410	35.47	22.06	23.75
Combined as one System	151,100	148,410	30.82	22.06	16.50

ULTIMATE

Municipality	Population	Population Served	Max.Day (mgd)	Avg.Day (mgd)	Storage Required (mg)
Separate Systems					
Fort William(1)	92,500	92,500	23.21	15.26	12.79
Neebing	7,200	6,500	1.72	0.86	2.15
Port Arthur(2)	92,200	92,200	22.28	14.38	12.49
Shuniah	9,900	8,900	2.36	1.18	2.53
TOTAL	201,800	200,100	49.57	31.68	29.96
Combined as one System	201,800	200,100	44.95	31.68	21.55

NOTES: (1) Including large industrial use increased at rate of 5 per cent per year to maximum of 3 mgd.

(2) including large industrial use increased at rate of 5 per cent per year to 1988 and 1 per cent per year thereafter.

VI

POLLUTION CONTROL

EXISTING FACILITIES

The present water pollution control facilities in the Lakehead are summarized in Table VI-1. In general, the type of treatment being provided is basic in nature.

Domestic

Domestic wastes receive primary treatment consisting of sedimentation, sludge removal and digestion before being discharged to the receiving watercourse. The effluent is also chlorinated during the period May 15 to November 1. This degree of treatment is provided currently at both the Port Arthur and Fort William WPCP's. The domestic wastes from waterfront industries receive little or no treatment before discharge to the watercourses. Generally the municipal sewers are not available or are laid at grades which are too high to accommodate the industries on the shore of Lake Superior or the banks of the Kaministikwia River. The domestic wastes from the Fort William Industrial Farm are discharged to a lagoon for stabilization. The approximate locations of this plant and the two municipal plants are shown in Figure VI-1.

The total yearly, maximum daily, average daily, and per capita flows for the two municipal plants are listed in Tables VI-2 and 3. Similar figures are not available for the industrial farm although they would be reflected by the water consumption at the farm. The quality of the effluent from each of the plants is listed in Table VI-4 along with the strength of the raw sewage.

In comparing these tables it is noted that the Fort William WPCP was not yet treating flows equivalent to its design capacity. It is also noted that the raw sewage entering the plant was very weak. For this reason the effluent from the plant was generally lower in BOD than is considered normal for the effluent from a primary plant. The reason for the weak raw sewage is the preponderance of combined sewers in the sewer system.

The average daily flow to the Port Arthur WPCP is exceeding the design capacity of the plant at the present time. The strength of the raw sewage is greater than that arriving at the Fort William plant but is still weaker than what would be considered normal for raw sewage. Again the large numbers of combined sewers is the reason for this. The effluent quality is normal for a primary plant.

The raw sewage being treated in the waste stabilization pond at the Fort William Industrial Farm has a greater BOD than that of normal domestic sewage but not unusual for this type of institution. This probably is due to the relatively large amounts of laundry and kitchen wastes generated at the farm.

<u>Industrial</u>

For the purpose of this report, the industries in the Lakehead can be separated into five categories:

1. Industries currently discharging to watercourses which are likely to continue to do so.

2. Industries currently discharging to watercourses which should be considered for discharge to a municipal water pollution control system.

3. Industries currently discharging wastes of a significant strength or volume to the municipal water pollution control system.

4. Industries currently discharging wastes of little or no significance to the municipal water pollution control system.

5. Industries with no significant liquid industrial waste discharge.

Industries which can be included in the last two of these categories are not of great concern providing their operations are maintained in the present state whereby waste effluents are relatively insignificant. A summary of the industries in the other categories together with their waste loadings is presented in Table VI-5.

With the possible exception of the thermal generating station, and the Dow Chemical Company all of the industries in Category 1 require additional waste treatment facilities. Each of the industries are completing plans for the improvement of their water pollution control systems. Cooling water discharges should be kept under close surveillance by the industries to ensure that no contaminants are contained therein. When these industries have implemented their pollution control programmes, a marked improvement should be evident in the quality of the surface water in the area, especially in the Kaministikwia River.

The "Category 2" industries with the exception of Kemp Fisheries Limited presently discharge their wastes or waste effluents directly to either the Kaministikwia River

or Lake Superior. The fishery stores its wastes and trucks them to the Port Arthur WPCP. The wastes from all of these industries should ultimately be considered for discharge to the municipal water pollution control systems. In order to do this, pretreatment will be required at the Ogilvie Flour Mills and possibly at Canada Malting. The wastes from the other industries are acceptable in their present form. It should be noted that Northern Wood Preservers already operate a pretreatment unit for the removal of phenols.

The industries in the third category, Canadian Car and Foundry Limited and Dorans Northern Brewery Limited, currently discharge their wastes directly to the municipal water pollution control systems. In the case of Canadian Car and Foundry, the wastes ultimately discharge to the Kaministikwia River without treatment. However, when the Fort William interceptor sewer is extended these wastes will be treated in the municipal plant. In the future, both industries may have to provide some pretreatment of their wastes depending on the effect they may have on treatment at the municipal water pollution control plants.

RECEIVING STREAM EVALUATIONS

In order to evaluate the capacity of a stream to receive waste discharges without seriously deteriorating the quality of the water or the aesthetics of the watershed, it is necessary to consider the various characteristics of the stream and the waste discharges. The flow and quality of the water in the stream and the quality and quantity of the wastes discharged to it must be carefully studied and correlated.

An assimilation study is the most accurate method of determining the allowable waste loading that a particular section or sections of a stream can receive. This requires a detailed study of the flow in the stream, the dissolved oxygen levels in the water, water temperature, the characteristics of the waste loadings and the quality of the river water. It is possible to predict the allowable waste loading for a stream fairly accurately by this method.

Where a detailed assimilation study is not available, conclusions can be reached based on less complete information such as water quality data from the stream monitoring programme, the average results of the analysis of samples of the waste effluents, and stream and waste flow figures. Further refinements can be made if consideration is given to the expected land use in the future and the desired aesthetics for the watershed.

Water Quality Objectives

In June 1967, the Ontario Water Resources Commission adopted policy guidelines for water quality objectives. These guidelines have been widely circulated throughout the Province and are available on request. In general, the guidelines are a descriptive outline of the policies to be followed by the Commission for the protection of the Province's water resources. Numerical values for the objectives are under active consideration at this time.

A summary of the water quality data as accumulated from the stream monitoring programme is given in Table VI-6. The following is a descriptive interpretation of the water quality for the major streams and Lake Superior.

Current River

The quality of the water in the Current River as determined at the monitoring station is presently satisfactory. Major discharges of wastes or waste effluents have not occurred in this watershed. Present indications are that these conditions will continue in the future as no extensive urbanization is forecast in the basin due to the difficult topography.

Recreational activity is extensive in the headwater zone of the Current River with cottage development almost encircling some of the lakes. Services for this type of development usually consist of wells and septic tanks and tile fields. The local health unit in the Lakehead has the responsibility for approving these. It is to their credit that little or no pollution is evident in the headwaters of the Current River.

McVicar Creek

The degree of urbanization in this small watershed is reflected in the water quality as measured at the monitoring station located near the mouth of the creek. Maximum recordings of the coliform count, and BOD have been excessive. Nutrient levels (nitrogen and phosphorus) were greater than those determined in the Current River water where less urbanization has occurred. Generally the average values of the analyses performed have indicated satisfactory water quality.

There are actually no direct waste or waste effluent discharges to the creek although overflow from combined storm and sanitary sewers probably occurs during periods of

above normal runoff. With the increased urbanization that is expected in the basin some deterioration in water quality may result. This should be avoided where practical by a conscientious programme of sewer separation.

McIntyre River

There are three points on the river where samples have been collected regularly over the past few years. These are located at the mouth of the river and upstream and downstream from the Port Arthur WPCP. The average results of the analyses of the samples taken upstream from the water pollution control plant indicate that the water quality is satisfactory. High coliform concentrations and BOD have been recorded at this point but do not occur regularly. Immediately downstream from the water pollution control plant outfall and at the mouth of the river, a noticeable deterioration in water quality is observed. Recorded values of coliform concentration, BOD, phosphorus, and nitrogen are excessive at these locations.

The poor quality of the river water here can be attributed to the inadequately treated waste discharges from the Port Arthur WPCP which provides primary treatment only. There is insufficient flow in the river to assimilate waste effluents such as this. Therefore it can be stated that this discharge should be removed from the river. Even if this is done, the water quality in the river may never recover completely due to the degree of urbanization expected in the basin in the future. For this reason, all new development should be served with separate storm and sanitary sewers and existing combined storm and sanitary sewers should be

replaced with separate systems in order to avoid combined sewage overflows during periods of heavy runoff.

Neebing River

The quality of the water in the Neebing River also reflects the degree of urbanization in the watershed and especially the periodic overflows from the combined storm and sanitary sewer system in the City of Fort William. Although BOD analyses indicated satisfactory water quality, coliform concentrations in the samples analysed were greater than the acceptable level. Nutrient values were also higher than normal.

Further deterioration of the water quality in the Neebing River is expected with the continuing development forecast in the basin. In order to reduce pollution and improve water quality all new development should be served by separate sewer systems. Where possible existing combined storm and sanitary systems should be separated. The Brunswick Avenue pumping station should be enlarged to prevent any direct discharges to the river. All waste effluent discharges should be prevented from entering the river.

Kaministikwia River

The water quality of the Mission and McKellar Rivers will also be discussed under this heading as all three are essentially the same watercourse. There are eight points on these rivers in the immediate area of the City of Fort William where samples have been taken fairly regularly during the past few years. These include three stations,

one at the mouth of each river. Reference is made to Figure VI-1 and Table VI-6 for the description and location of each of these sampling points.

The water quality is greatly impaired by the discharges of untreated or partially treated, process and domestic wastes from the industries located on the banks of the river. In addition, there are numerous outlets from the combined sewer system in the City of Fort William which discharge to the river. The results of these discharges are high recorded values of the BOD, coliform concentration, nutrients, phenols and other less significant elements. In addition to these industrial discharges and combined sewer overflows, the City of Fort William WPCP discharges its effluent to the Kaministikwia River proper, upstream from the mouth of the river.

A recent biological survey of the Kaministikwia River revealed that the water quality of the river was unimpaired to a point approximately five miles from the river mouths. Between this point and the mouths the water quality was severely impaired as a result of industrial and domestic wastes. Considerable improvement in quality was evident at the mouths however. This conclusion supports the sanitary chemical quality of the water as outlined in Table VI-6.

In the future it is anticipated that the industries currently discharging to this watercourse will either provide adequate waste treatment or redirect their wastes to the municipal sewage treatment plant. The Fort William WPCP will ultimately discharge its effluent directly to

Lake Superior. It is also hoped that in the future the separation of combined storm and sanitary sewers will be practical. Following these improvements, the quality of the Kaministikwia River water should be greatly improved. At the present time, the tremendous flow in the river is all that prevents the water quality from being more seriously affected by the great amounts of waste being discharged to it.

Lake Superior

During recent years a fairly extensive sampling programme has been pursued in the Lakehead waterfront area by the local health unit and the OWRC. This has resulted in a relatively comprehensive picture of the water quality in the lake.

Generally, the lake water quality is satisfactory in the lakefront area. In the vicinity of sewer outfalls which discharge inadequately treated domestic or industrial wastes, high recorded values of the BOD, coliform concentration, phenols and nutrients have been encountered in the water. This is especially noticeable in the area of the Lillian and Clarke Streets outfalls from the Port Arthur sewer system and the outfalls from Abitibi Provincial Paper Limited and the Thunder Bay Mill of the Abitibi Paper Company Limited.

The phosphate concentrations measured should be carefully considered. Algae growths have been reported in several areas along the shoreline recently. Increasing levels of phosphorus would result in more prolific growths

resulting ultimately in nuisance conditions.

The conclusions of a recent biological survey of Thunder Bay were that water of reasonably good quality was present along the western shore of Thunder Bay, with only localized areas of organically contaminated water near the mouths of the Kaministikwia River, within the Lakehead Harbour, and in the vicinity of the waste discharges from the Abitibi Paper Company's Thunder Bay Mill. According to the report, a large portion of Thunder Bay contained water of excellent quality. These conclusions are supported by the sanitary water quality as outlined in Table VI-6.

Future indications are that water quality in the lake should improve providing continued progress is made in pollution control in the Lakehead Area. The steps necessary to achieve this will be the adequate treatment of all industrial and domestic wastes, a conscientious programme of combined sewer separation when and where practical and the assurance that new sources of pollution will be avoided at any cost.

GENERAL CONSIDERATIONS

It is evident from the review of the water quality in the drainage basins of the Lakehead and even in Lake Superior that many improvements are needed in the area's water pollution control facilities. With the possible exception of the Kaministikwia River system, the watercourses in the urbanizing area are inadequate in terms of assimilating capacity for waste and waste effluent discharges from any

source. In the case of the Kaministikwia River, some properly treated waste effluents can probably be assimilated adequately by the flow. Nevertheless, the proximity of Lake Superior with its much greater capacity for absorption of pollutants makes it the logical choice over the river wherever practical. Ideally all pollution control facilities in the Lakehead ultimately will be oriented to the lake.

At the present time there are areas in both the City of Fort William and the City of Port Arthur which are not connected to the municipal water pollution control plants. In both cases extensions to main interceptor sewers are required to provide the necessary links. If the growth suggested in Section III occurs as forecast, new trunk sewer systems will also be required to serve new development.

Complicating this problem is the fact that the existing sewer systems in both municipalities are comprised of combined storm and sanitary sewers. Ideally these should be separated. However, the capital expenditure that would be required to undertake such a programme may be prohibitive, especially when added to the cost of the other facilities that are needed. Nevertheless this inadequacy should be recognized and corrective measures taken whenever practical.

Presently the municipal waste treatment provided in the Lakehead is primary in nature. The review of the water quality undertaken previously in this section of the report indicates that higher degree of treatment is required. Secondary treatment will reduce the BOD further and also the solids loading but will not reduce the nutrients which are apparently increasing in the surface waters of the area.

Therefore it is probable that an alternate form of treatment which will reduce BOD and also nutrients would be desirable. Lime coagulation and sedimentation would appear to be suitable as the existing primary treatment could be readily adapted to it.

In general, one large water pollution control plant can be built and operated more economically than two smaller plants with a combined capacity equivalent to that of the larger plant. This statement could be applied to the present situation in the Lakehead where two municipal plants, which are close together, are presently being operated. It appears reasonable to expect that in the future, treatment should be provided by a single plant with an outfall to Lake Superior. Initially this would probably be a primary plant which could be converted to provide the required degree of treatment as mentioned previously, at a later date.

Industry in the Lakehead area has been completing plans for adequate waste treatment facilities during the past few years. At the present time however, there are many inadequacies in the methods of waste treatment employed by the industries. As was indicated earlier in this section, some industries will be required to provide their own treatment facilities for the foreseeable future. The waste discharges from others require pretreatment before discharge to the municipal systems for ultimate disposal. Still others may require no treatment prior to discharge to the municipal water pollution control system. A few industries which utilize water for cooling or other similar uses which do not contaminate, require no treatment at all.

In this report, no consideration has been given to the actual facilities required by the industries except where an industry may be discharging to the municipal system. In this latter case, allowances have been made in the capacity of the municipal system to accommodate these wastes. Otherwise the report has generally identified the industrial waste treatment problem in the Lakehead.

Pollution control in the areas of the study region remote from the urbanizing Lakehead has also been considered. Extensive growth in the existing communities inland from the lake is not forecast. Therefore it is suggested that development which may occur in these areas should be served by individual pollution control facilities. If hamlets such as Kakabeka Falls, Murillo or Rosslyn should expand significantly, communal sewage treatment facilities will be necessary. If such facilities cannot be provided at a reasonable cost, or where an adequate receiving stream is not available, development should be restricted.

There has been some pressure for development in the Municipality of Neebing south of the Kaministikwia River. It is probable that a sewer system with a treatment plant discharging to the Kaministikwia River could be allowed without deteriorating the river's water quality significantly. Any such development south of the Kaministikwia River should be self-sufficient in terms of sanitary sewer services. The full cost of sewage collection and treatment should be levied as developer charges against development in the area. However, when the inadequacies of the existing pollution control systems north of the river are considered, it would seem more than reasonable to concentrate the efforts

of the existing community and those of new development in solving existing problems before establishing new areas with independant servicing arrangements. Any development south of the Kaministikwia River might penalize those areas north of the river which presently have servicing problems since these problems may only be solved when money from new development becomes available for the required improvements. Therefore it is suggested that in the interests of sound planning development south of the Kaministikwia River be postponed.

DESIGN CRITERIA

In order to determine the required capacities of the treatment facilities and the trunk sewers, consideration was given to both the population projections and the area to be served. Section III in the report outlines the estimated future population and the area it will probably occupy.

At the present time not all of the areas within the two cities are sewered. However, as design stages of ten years have been investigated, it was assumed that the entire area of the two cities will be sewered by 1978. In extending services into the Municipalities of Neebing and Shuniah it was realized that the entire population projected for these municipalities could not be serviced practically in the initial stages. It was also realized that a portion of the population of each municipality would remain rural. This portion was assumed to be ten per cent. The following table indicates the population in Neebing and Shuniah which will be served at each stage in the development of the

pollution control system.

	MUNICIPALITY OF NEEBING			MUNICIPALITY OF SHUNIAH		
Year	Est. Pop.	Percent Served	Pop. Served	Est. Pop.	Percent Served	Pop. Served
1978	4,600	50	2,300	7,600	50	3,800
1988	5,300	75	4,000	8,600	75	6,450
Ultimate	7,200	90	6,500	9,900	90	8,900

Currently, per capita sewage flows to the Port Arthur and Fort William water pollution control plants are high (Tables VI-2 and VI-3). It is anticipated that as the two cities become completely sewered and some separation of combined sewers is undertaken, and considering that new development will be served with completely separate storm and sanitary sewer systems, the per capita sewage flows will be reduced to approximate the per capita water consumption figures. Therefore, the hydraulic capacity of the water pollution control plant suggested in the report has been based upon a per capita sewage flow equivalent to the per capita water consumption plus an allowance for the wet industries which should be connected to the system.

In calculating the required capacity of the trunk sewers a contributory flow of 0.01 cfs per acre was utilized. This figure includes an allowance for infiltration and also a peak flow factor. The sewers were sized to accommodate the ultimate development area. A Manning's roughness coefficient of 0.013 was used for the design of the gravity sewers. Slopes were calculated from information obtained from the Department of National Defence 1 in 50,000 scale topographic maps showing 25 foot contours and also from maps of the

Lakehead Metropolitan Area showing 5 foot contour intervals where these were available. These maps were originally produced for the Lakehead Planning Board. A Hazen-Williams "C" factor of 130 was used in the design of forcemains which were sized to accommodate the 20-year design flows.

ADDITIONAL WORKS REQUIRED

The suggested water pollution control system to serve the existing Cities of Fort William and Port Arthur and the urbanizing areas of the Municipalities of Neebing and Shuniah is outlined in Figure VI-1. By 1988 a treatment plant capacity of 22 mgd will be required. Following are the reasons for this suggested system.

Treatment Facilities

The two primary sewage treatment plants in Fort William and Port Arthur are being utilized at or near their capacity at the present time. In the near future expansions will be required at both plants. For this reason the economics of continuing to operate two plants and of expanding each plant as required was investigated. It appears that it would be more economical to operate a single plant and expand it than to continue with two separate plants. In arriving at this observation, the following alternatives were studied.

Alternative 1 Both the existing Fort William and Port Arthur primary water pollution control plants could be expanded at their present locations. If this were done, outfall sewers discharging to Lake Superior would be required at both plants in order to protect the water quality in the Kaministikwia and McIntyre Rivers.

<u>Alternative 2</u> The existing Port Arthur WPCP could be converted to a sewage pumping station which would transfer Port Arthur's sewage to the Fort William pollution control system. The Fort William primary plant could then be expanded to treat the entire sewage flow from the area. In this case only one outfall discharging to Lake Superior would be required to protect the water quality of the Kaministikwia River.

<u>Alternative 3</u> Both of the existing primary plants could be expanded and converted to secondary water pollution control plants. As the McIntyre River has very little assimilative capacity an outfall sewer would still be required from the Port Arthur plant to Lake Superior. If secondary treatment were provided, Fort William could continue to discharge to the Kaministikwia River.

<u>Alternative 4</u> As outlined in Alternative 2, the Port Arthur WPCP could be converted to a pumping station. The Fort William WPCP would be expanded to treat the sewage flow from the entire area and would be converted to secondary treatment. The effluent from the secondary treatment plant could be discharged to the Kaministikwia River. A new outfall would be required due to the lack of sufficient capacity in the existing outfall.

<u>Alternative 5</u> Both the existing plants could be expanded and converted to intermediate treatment plants. Again an outfall would be required from the Port Arthur WPCP to Lake Superior due to the inadequate assimilative capacity in the McIntyre River. The effluent from the Fort William

WPCP could continue to be discharged to the Kaministikwia River if the plant is converted to intermediate treatment.

<u>Alternative 6</u> The Port Arthur WPCP would be converted to a pumping station as outlined in Alternative 2. The Fort William WPCP would be expanded to treat the entire sewage flow from the area and would be converted to intermediate treatment. The effluent from the intermediate treatment plant could be discharged to the Kaministikwia River. A new outfall would have to be constructed to accommodate the entire flow.

<u>NOTE</u>: In this report the term "intermediate treatment" is intended to signify a degree of sewage treatment which will produce a reduction in BOD and suspended solids of approximately 70 per cent or greater and a phosphorus reduction of 90 per cent from the raw sewage to the final effluent. At the present time information suggests that chemical precipitation by means of lime coagulation and sedimentation followed by recalcination of the sludge to reclaim the lime could accomplish this degree of treatment. Air stripping for the removal of ammonia also could be provided easily following this process.

For the purposes of comparison, primary treatment produces BOD and suspended solids reductions of 35 and 65 per cent respectively on the average but no phosphorus reduction. Conventional activated sludge secondary treatment produces BOD and suspended solids reductions of greater than 90 per cent on the average but little or no phosphorus reduction.

These six alternatives were studied in some detail with consideration being given to capital cost, operating cost and also the most desirable type of treatment for the maintenance of satisfactory water quality in the Lakehead. Alternatives 2 and 6 were the most economical and appear to be almost equal in merit from a water quality standpoint. Ultimately, however, a degree of treatment superior to primary treatment will be necessary to curb the increasing

nutrient levels and BOD in the surface waters. Ideally the water pollution control facilities for the urban area of the Lakehead would consist of a single plant at the site of the existing Fort William WPCP providing intermediate treatment and discharging to Lake Superior. Considering this, it is obvious that either Alternative 2 or 6 could be adopted as interim stages as both could be adapted readily to the ultimate scheme for pollution control.

Sewer Areas

For purposes of description, the two cities and the urbanizing area of the surrounding municipalities can be divided into four sewer areas. These are; the area served by the Port Arthur WPCP at present; the area served by the Fort William WPCP at present; and two new areas which would be contributory to new trunk sewers following the McIntyre and Neebing Rivers.

In the existing areas there are inadequacies which should receive immediate attention. On the other hand, if new development is to be encouraged, the required services must be provided in the two new sewer areas. Therefore, the decision as to which works receive priority will be involved and difficult.

Port Arthur Sewer Area

This area encompasses practically all of the existing development in the City of Port Arthur. The inadequacies of the sewage collection system are that the Lillian Street and Clark Street sewers still discharge to Lake Superior; that there probably will be inadequate capacity in the main

north-south trunk sewer when the above two areas are connected; and that many of the sewers combine storm and sanitary flows.

The trunk collector system should be extended as soon as possible to Clark Street and Lillian Street to prevent further discharges from these sewers to Lake Superior. In order to relieve the flow which may subsequently occur in the main north-south trunk sewer, several steps may be taken. A second north-south trunk might be constructed or some areas on the fringe of the sewer area might be diverted into the McIntyre River trunk sewer which this report proposes. These areas are the area at the extremity of the John Street trunk sewer and the as yet undeveloped area immediately west of the existing sewage treatment plant in the vicinity of the Lakehead University. The two sub-areas in question are outlined by means of question marks and arrows in two directions in Figure VI-1. The separation of storm and sanitary flows wherever possible would also help to alleviate the load on the main north-south trunk sewer. Eventually it is anticipated that all of these steps will be taken to overcome the inadequacies in this sewer area.

Fort William Sewer Area

This area is made up of the part of the City of Fort William which lies between the Kaministikwia and Neebing Rivers. To provide adequate servicing of this area, the Kaministikwia River interceptor sewer needs to be extended to the western boundary of Fort William. The

Brunswick Avenue pumping station situated on the south side of the Neebing River has been overloaded. However, with the new proposal of this report for a Neebing River trunk sewer, the area in the north-west corner of the city north of the Neebing River would be redirected and may eliminate extensive expansion of this pumping station.

The majority of the collection system south of the Neebing River is comprised of combined sewers. A programme of separation should be undertaken wherever practical. Depending upon the success of such a programme, it may be possible to extend the Kaministikwia interceptor to serve development in Neebing Township between the Kaministikwia River and the airport. Otherwise this area may have to be directed to the new proposed Neebing River trunk sewer. The separation programme would also greatly alleviate hydraulic overloads at the Brunswick Avenue pumping station and also the treatment plant.

Sewer service possibly could be provided on Mission and McKellar Islands if considered desirable. Two pumping stations would probably be required. The capital cost to provide the service would be high. In all probability, if further development is encouraged on the islands it should be of the type that can be accommodated on individual facilities. Otherwise the islands might be restricted to open space uses.

McIntyre River Sewer Area

The McIntyre River sewer area includes all of the land draining to the river in the Municipality of Shuniah plus certain areas in the City of Port Arthur located on the

western boundary of the city. The proposed route of the trunk sewer which would serve this area would follow the river west to Golf Links Road and then turn northward. A sub-trunk would probably continue west from the point where the main trunk first meets Golf Links Road (See Figure VI-1). This sewer should be designed to accommodate development for the foreseeable future in this area and to allow for the redirection of some existing sewered areas in Port Arthur thus providing relief to the existing sewer system as stated previously.

Neebing River Sewer Area

This area consists of the north-west corner of the City of Fort William north of the Neebing River and the land lying in the watershed in the Municipalities of Neebing and Shuniah which is expected to develop as outlined in Section III of this report. The proposed trunk sewer to serve this area would roughly follow the river from Neebing through the City of Fort William and join the McIntyre River trunk sewer as outlined in Figure VI-1. From the junction of the two sewers, the sewage would be conveyed to the site of the existing Fort William WPCP by a new trunk sewer which would also collect the sewage being transferred via pumping station and forcemain from the Port Arthur sewer area.

As stated previously, the Neebing River trunk sewer would relieve the load at the Brunswick Avenue pumping station by intercepting the flow directed to it from the north side of the river. This sewer might also collect flows from the Rosslyn Road area of Neebing if capacity

cannot be provided in the Kaministikwia interceptor sewer. To do this, a trunk sewer or possibly a pumping station and forcemain would have to be constructed to direct the flow of sewage northward along the Fort William boundary from Rosslyn Road to the Neebing River as shown in Figure VI-1.

TABLE VI-1

SUMMARY OF WATER POLLUTION CONTROL FACILITIES

A. DOMESTIC

Plant	Type	Rated Capacity	Receiving Watercourse
1. Fort William	Primary	6.0 mgd	Kaministikwia River
2. Fort William Industrial Farm	Lagoon	19,000 gpd	Mosquito Creek (Kam. R.)
3. Port Arthur	Primary	4.0 mgd	McIntyre River

B. INDUSTRIAL

1. Abitibi Paper Company Mission Mill	Settling Lagoons	11.4 mgd*	Lake Superior
2. Abitibi Prov. Paper Ltd.	Settling Lagoon	-	Lake Superior
3. Abitibi Paper Company Thunder Bay	Settling Lagoon	-	Lake Superior
4. Dow Chemical of Canada Ltd.	Neutralization	35,000 gpd	Kaministikwia River
5. Great Lakes Paper Co. Ltd.	Clarification & Neutralization Outfall Sewer	4.8 mgd 25 mgd	Kaministikwia River
6. Lakehead Co-Operative Abattoir Ltd.	Anaerobic & Aerobic Lagoons	10,000 gpd	Corbett Creek (Kam. R.)
7. Northern Wood Preservers Ltd.	Phenol Oxidation	5,000 gpd	Lake Superior
8. The Ogilvie Flour Mills Co. Ltd.	Flume Collector System	300,000 gpd	Kaministikwia River

* - not completed

TABLE VI-2

FORT WILLIAM WPCP - SEWAGE FLOW

Year	Total mg	Max.Day mgd	Avg.Day mgd	Population Served*	Per Capita Flow gpcd
1964**	424.01	8.53	2.099	18,600	113
1965	676.38	7.92	1.850	18,900	98
1966	995.52	7.21	2.730	21,600	126
1967	1,441.77	10.86	3.950	31,300	126
1968***	-	11.67	4.720	-	-

* - estimated sewered population

** - June 13 to year end

*** - up until Sept. 1968

TABLE VI-3

PORT ARTHUR WPCP - SEWAGE FLOW

Year	Total mg	Max.Day mgd	Avg.Day mgd	Population Served*	Per Capita Flow gpcd
1960**	-	3.180	1.613	-	-
1961	840.41	4.91	2.302	-	-
1962	885.49	5.15	2.426	-	-
1963	1,063.67	5.65	2.914	27,000	108
1964	1,648.94	7.98	4.505	31,800	141
1965	1,883.74	8.01	5.161	34,500	150
1966	1,825.52	7.91	5.001	34,700	144
1967	1,813.46	8.20	4.968	35,000	142
1968***	-	8.00	5.360	-	-

* - estimated sewered population

** - in operation latter part of year only

*** - up until Sept. 1968

TABLE VI-4

EFFLUENT QUALITY

Plant	Date		RAW BOD ppm	RAW Susp.Solids ppm	EFFLUENT BOD ppm	EFFLUENT Susp.Solids ppm
City of Fort William WPCP	1965-1968	No.of Samples	28	28	27	27
		Average	63	109	34	65
		Maximum	135	230	79	139
		Minimum	26	52	4	36
City of Port Arthur WPCP	1963-1967	No.of Samples	119	119	118	118
		Average	155	222	74	83
		Maximum	520	522	190	176
		Minimum	51	73	20	30
Municipality of Neebing Ft.William Ind. Farm	1966-1968	No.of Samples	17	17	17	17
		Average	282	198	52.2	32
		Maximum	940	982	300	124
		Minimum	30	32	3.6	3

TABLE VI-5

INDUSTRIAL WASTE DATA

A. SUMMARY - CATEGORY 1

		DATA FROM MAY 1967 SURVEY			TYPICAL WASTE LOADINGS*		
Municipality	Industry	BOD Tons/day	S.S. Tons/day	Flow MGD	BOD Tons/day	S.S. Tons/day	Flow MGD
City of Fort William	Abitibi Paper Co. Ltd Mission Mill	13.35	15.28	12.94	25	5	11.4
	Dow Chemical of Canada Ltd.	cooling water	-	0.7 to 1.0	-	-	-
	H.E.P.C. Thunder Bay Thermal Generating Sta.	cooling water	-	80	-	-	-
City of Port Arthur	Abitibi Paper Co. Thunder Bay	23.1	1.2	14.0	20	5	12
	Abitibi Provincial Paper Ltd.	28.3	12.7	17.5	25	15	22
Municipality of Neebing	Great Lakes Paper Co.	138.0	78.0	63.0	135	100	55

* - obtained from industry

TABLE VI-5
(Cont'd)

INDUSTRIAL WASTE DATA

B. SUMMARY - CATEGORY 2

Municipality	Industry	Date	WASTE DATA						
			BOD	Susp. Solids	Diss. Solids	Phosphates	Phenol	pH	Flow
City of Fort William	Industrial Grain Products Ltd. (Ogilvie Flour Mill Co. Ltd.)	Sept.1966	11,700 lb/day	4,130 lb/day	-	-	-	-	213,000 gpd
City of Port Arthur	Canadian Liquid Air Ltd.	May 1967	-	46 lb/wk	1,158 lb/wk	0.024 lb/wk	-	12.1	600 gpwk
	Canada Malting Co. Ltd.	Sept.1966	3,300 lb/day	535 lb/day	-	-	-	-	500,000 gpd
	Kemp Fisheries Limited	- Wastes stored and trucked to Port Arthur WPCP - No record of strength or volume							
	Northern Wood Preservers	Sept.1966	-	-	-	-	0.3 lb/day	-	5,000 gpd

TABLE VI-5
(Cont'd)

INDUSTRIAL WASTE DATA

C. SUMMARY - CATEGORY 3

Municipality	Industry	BOD lb/day	Susp.Solids lb/day	pH	Chromium lb/day Total	Chromium lb/day Hex.	Cyanide lb/day	Flow gpd
		DATA FROM MAY 1967 SURVEY						
City of Fort William	Canadian Car & Foundry Limited*	-	-	3.9	35	19.2	1.2	350,000
City of Port Arthur	Dorans Northern Brewery Ltd.**	1,165	227	4.4	-	-	-	70,000

* - Discharge to municipal sewer system which in turn discharges directly to Kaministikwia River.

** - Dorans also dumps 250 lb. of excess yeast 8-12 times each week

- typical yeast analysis BOD - 38,300 ppm
  S.S. - 24,530 ppm
  COD - 90,000 ppm

TABLE VI-6

SANITARY WATER QUALITY

(A) LAKE SUPERIOR (i) Station Descriptions

Sampling Point Number	Sampling Point Location	Period of Sampling
LS-1	North-east of discharge from Abitibi Paper Co. Ltd., Thunder Bay Mill	June 1965 to September 1967
LS-2	South-west of discharge from Abitibi Paper Company Ltd., Thunder Bay Mill	June 1965 to September 1967
LS-3	North of Lillian Street Sewer Outfall	July 1965 to September 1967
LS-4	South of Lillian Street Sewer Outfall	July 1965 to September 1967
LS-5	Near discharge from Abitibi Provincial Paper Ltd.	June 1965 to September 1967
LS-6	Near mouth of Current River	June 1965 to May 1967
LS-7	Near United Grain Grower Elevator and Saskatchewan Wheat Pool Elevators No. 4A and B	June 1965 to September 1967
LS-8	Near Clark Street Sewer Outfall	July and August 1965
LS-9	Near mouth of McVicar Creek	July and August 1965
LS-10	Near C.P.R. Freight Sheds	June 1965 to September 1967
LS-11	Near former location of C.N.R. Freight Sheds No. 4	June 1965 to September 1967
LS-12	At foot of Wilson Street	June 1965 to September 1967
LS-13	Near Saskatchewan Wheat Pool Elevator No. 6	June 1965 to September 1967
LS-14	At foot of John Street near Sewer Overflow	June 1965 to September 1967
LS-15	Near Northern Wood Preservers Limited	June 1965 to September 1967
LS-16	Near Saskatchewan Wheat Pool Elevator No. 7 and Stewart Elevator	June 1965 to September 1967

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

(A) LAKE SUPERIOR (i) Station Descriptions

Sampling Point Number	Sampling Point Location	Period of Sampling
LS-17	Near mouth of McIntyre River	June 1965 to September 1965
LS-18	Near Keefer Terminal	June 1965 to September 1967
LS-19	Near mouth of Neebing River	June 1965 to October 1965
LS-20	Mouth of Kaministikwia River	June 1965 to October 1965
LS-21	Kaministikwia River near Fort William WPCP Outfall	June 1965 to October 1965
LS-22	Mouth of Mission River	June 1965 to October 1965
LS-23	Mouth of McKellar River	June 1965 to October 1965
LS-24	Kaministikwia River near Saskatchewan Wheat Pool Elevator No. 8	June 1965 to October 1965

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

(ii) Maximum, Minimum and Average Values

Analysis			LS-1	LS-2	LS-3	LS-4	LS-5	LS-6
			Sampling Point Number					
Coliforms per 100 c.c. (M.P.N.)	No.of	Samples	9	9	8	9	9	4
	Log.	Average	20	158	85	64	6,900	2,630
		Maximum	2,300	7,500	2,300	4,300	430,000	21,000
		Minimum	0	0	9	4	430	430
BOD_5 (ppm)	No.of	Samples	10	10	9	9	10	6
		Average	1.2	9.5	3.3	2.5	19.5	2.5
		Maximum	2.6	45.0	18.0	11.0	97.0	6.0
		Minimum	0.1	0.3	0.4	0.4	2.2	0.5
Total Solids (ppm)	No.of	Samples	7	10	9	9	10	6
		Average	76	106	84	82	181	120
		Maximum	104	260	136	122	526	262
		Minimum	40	58	60	52	92	70
Suspended Solids (ppm)	No.of	Samples	8	9	9	9	10	6
		Average	4	10	6	6	21	10
		Maximum	9	40	13	16	85	17
		Minimum	1	1	1	1	6	4
Dissolved Solids (ppm)	No.of	Samples	7	9	8	8	9	6
		Average	72	96	78	76	160	110
		Maximum	95	220	100	118	441	252
		Minimum	34	52	59	49	83	66
Turbidity (Units)	No.of	Samples	5	5	5	5	5	1
		Average	5.4	10.1	3.9	5.0	31.1	12.5
		Maximum	13.5	23.0	6.5	12.5	108.0	-
		Minimum	2.8	2.6	2.5	2.6	7.5	-
pH at OWRC Lab.	No.of	Samples	4	5	5	5	5	1
		Average	7.2	7.4	7.4	7.6	7.3	7.6
		Maximum	7.5	8.2	8.2	8.3	8.1	-
		Minimum	6.6	6.2	6.9	7.2	6.8	-
Calcium as Ca (ppm)	No.of	Samples	4	5	0	0	5	0
		Average	14	14	-	-	22	-
		Maximum	14	15	-	-	35	-
		Minimum	13	13	-	-	15	-
Magnesium as Mg (ppm)	No.of	Samples	4	5	0	0	5	0
		Average	4	4	-	-	4	-
		Maximum	4	5	-	-	6	-
		Minimum	3	3	-	-	3	-
Sulphite as SO_3 (ppm)	No.of	Samples	5	5	0	0	5	0
		Average	1.2	1.6	-	-	2.2	-
		Maximum	4.0	4.0	-	-	5.0	-
		Minimum	0.0	0.0	-	-	0.0	-

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		Sampling Point Number LS-1	LS-2	LS-3	LS-4	LS-5	LS-6
Phenols (ppb)	No.of Samples	10	10	9	9	10	6
	Average	8	15	12	8	16	14
	Maximum	20	50	60	20	30	30
	Minimum	0	0	0	0	4	4
Total Phosphorus as PO_4 (ppm)	No.of Samples	4	4	3	3	4	4
	Average	0.05	0.07	0.15	0.08	0.17	0.11
	Maximum	0.08	0.12	0.24	0.16	0.30	0.20
	Minimum	0.02	0.04	0.02	0.02	0.10	0.06
Dissolved Oxygen Saturation (%)	No.of Samples	6	6	5	5	5	1
	Average	97	88	96	94	47	60
	Maximum	112	110	112	103	68	-
	Minimum	63	39	63	81	19	-

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		LS-7	LS-8	LS-9	LS-10	LS-11	LS-12
		Sampling Point Number					
Coliforms per 100 c.c. (M.P.N.)	No.of Samples	10	7	2	9	8	10
	Log. Average	8,475	574,000	1,904	2,488	815	1,343
	Maximum	93,000	11,000,000+	3,900	23,000	2,300	23,000
	Minimum	1,500	24,000	930	930	230	230
BOD_5 (ppm)	No.of Samples	10	7	2	10	9	10
	Average	2.6	4.7	0.8	1.8	1.3	1.5
	Maximum	6.6	16.0	1.1	2.9	2.6	2.7
	Minimum	1.1	0.9	0.5	0.7	0.4	0.4
Total Solids (ppm)	No.of Samples	10	7	2	10	9	10
	Average	100	141	108	90	100	101
	Maximum	132	222	130	110	126	130
	Minimum	74	96	86	56	80	80
Suspended Solids (ppm)	No.of Samples	10	7	2	10	9	10
	Average	11	34	35	8	8	8
	Maximum	16	120	62	11	15	12
	Minimum	6	10	8	3	4	3
Dissolved Solids (ppm)	No.of Samples	9	6	2	9	8	9
	Average	89	107	73	82	92	93
	Maximum	122	154	78	107	121	118
	Minimum	66	82	68	51	67	77
Turbidity (Units)	No.of Samples	5	5	0	5	4	5
	Average	7.4	21.9	-	9.9	10.6	6.2
	Maximum	13.5	59.0	-	26.0	27.0	13.0
	Minimum	2.8	5.0	-	3.5	4.0	3.6
pH at OWRC Lab.	No.of Samples	5	5	0	5	4	5
	Average	7.2	7.2	-	7.4	7.6	7.4
	Maximum	8.2	8.2	-	8.3	8.8	8.1
	Minimum	6.9	6.7	-	7.0	7.1	7.1
Calcium as Ca (ppm)	No.of Samples	0	0	0	0	0	0
	Average	-	-	-	-	-	-
	Maximum	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-
Magnesium as Mg (ppm)	No.of Samples	0	0	0	0	0	0
	Average	-	-	-	-	-	-
	Maximum	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-
Sulphite as SO_3 (ppm)	No.of Samples	0	0	0	0	0	0
	Average	-	-	-	-	-	-
	Maximum	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		Sampling Point Number LS-7	LS-8	LS-9	LS-10	LS-11	LS-12
Phenols (ppb)	No.of Samples	10	7	2	10	9	10
	Average	16	13	1	7	7	8
	Maximum	40	40	2	15	15	20
	Minimum	0	2	0	4	2	2
Total Phosphorus as PO_4 (ppm)	No.of Samples	4	2	2	4	4	4
	Average	0.09	0.54	0.27	0.16	0.13	0.20
	Maximum	0.12	0.72	0.32	0.36	0.24	0.32
	Minimum	0.08	0.36	0.21	0.06	0.08	0.10
Dissolved Oxygen Saturation (%)	No.of Samples	5	4	0	5	5	5
	Average	74	72	-	86	78	84
	Maximum	83	78	-	98	88	88
	Minimum	67	68	-	68	55	73

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		Sampling Point Number LS-13	LS-14	LS-15	LS-16	LS-17	LS-18
Coliforms	No.of Samples	9	9	9	9	5	9
per 100	Log. Average	1,376	1,936	2,717	18,370	16,540	8,228
c.c.	Maximum	7,500	9,300	23,000	430,000	210,000	930,000
(M.P.N.)	Minimum	430	230	73	230	930	430
BOD_5	No.of Samples	10	10	10	10	5	9
(ppm)	Average	1.3	1.2	1.4	1.5	3.3	1.3
	Maximum	2.9	2.6	2.7	2.7	5.0	2.2
	Minimum	0.4	0.1	0.3	0.6	1.8	0.4
Total	No.of Samples	10	10	10	10	5	9
Solids	Average	85	85	88	104	124	94
(ppm)	Maximum	100	130	114	124	184	132
	Minimum	60	48	54	80	84	60
Suspended	No.of Samples	10	10	10	10	5	9
Solids	Average	8	7	7	8	13	8
(ppm)	Maximum	13	11	11	11	20	16
	Minimum	5	5	4	3	8	3
Dissolved	No.of Samples	9	9	9	9	5	9
Solids	Average	77	78	81	96	111	86
(ppm)	Maximum	92	123	103	115	164	123
	Minimum	47	38	50	69	73	56
Turbidity	No.of Samples	5	5	5	5	0	5
(Units)	Average	9.2	6.0	5.8	6.4	-	10.4
	Maximum	27.0	12.0	11.0	11.5	-	29.0
	Minimum	3.1	2.6	3.5	2.9	-	2.3
pH at	No.of Samples	5	5	5	5	0	5
OWRC	Average	7.5	7.4	7.4	7.7	-	7.5
Lab.	Maximum	8.2	7.7	7.7	9.2	-	8.4
	Minimum	6.9	7.1	7.0	7.0	-	7.1
Calcium	No.of Samples	0	0	0	0	0	0
as Ca	Average	-	-	-	-	-	-
(ppm)	Maximum	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-
Magnesium	No.of Samples	0	0	0	0	0	0
as Mg	Average	-	-	-	-	-	-
(ppm)	Maximum	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-
Sulphite	No.of Samples	0	0	0	0	0	0
as SO_3	Average	-	-	-	-	-	-
(ppm)	Maximum	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		Sampling Point Number LS-13	LS-14	LS-15	LS-16	LS-17	LS-18
Phenols (ppb)	No.of Samples	10	10	10	10	5	9
	Average	6	6	6	6	4	7
	Maximum	10	10	10	10	6	30
	Minimum	2	2	2	0	2	0
Total Phosphorus as PO_4 (ppm)	No.of Samples	4	4	4	4	4	3
	Average	0.17	0.15	0.16	0.31	1.13	0.15
	Maximum	0.24	0.24	0.24	0.50	4.20	0.20
	Minimum	0.14	0.04	0.06	0.20	0.28	0.12
Dissolved Oxygen Saturation (%)	No.of Samples	5	5	5	5	1	5
	Average	88	84	83	79	57	78
	Maximum	92	92	88	87	-	87
	Minimum	83	73	73	70	-	64

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis			Sampling Point Number LS-19	LS-20	LS-21	LS-22	LS-23	LS-24
Coliforms per 100 c.c. (M.P.N.)	No.of	Samples	5	5	5	5	5	2
	Log.	Average	12,460	3,502	13,420	6,191	1,487	654,200
		Maximum	110,000	24,000	11,000,000+	43,000	9,300	4,600,000
		Minimum	930	1,500	930	2,300	210	93,000
BOD_5 (ppm)	No.of	Samples	5	4	5	4	5	4
		Average	1.6	3.7	5.9	5.5	2.8	160.8
		Maximum	3.2	6.8	10.0	10.0	8.8	295.0
		Minimum	0.4	1.0	0.8	1.5	0.7	38.0
Total Solids (ppm)	No.of	Samples	5	4	5	4	5	4
		Average	160	103	153	133	100	304
		Maximum	194	140	210	172	128	452
		Minimum	128	72	74	78	80	162
Suspended Solids (ppm)	No.of	Samples	5	4	5	4	5	4
		Average	8	13	11	21	12	132
		Maximum	19	21	12	50	14	240
		Minimum	2	6	8	5	10	68
Dissolved Solids (ppm)	No.of	Samples	5	4	5	4	5	4
		Average	152	90	142	112	88	172
		Maximum	183	119	202	138	118	212
		Minimum	126	65	63	73	66	94
Turbidity (Units)	No.of	Samples	0	0	0	0	0	0
		Average	-	-	-	-	-	-
		Maximum	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-
pH at OWRC Lab.	No.of	Samples	0	0	0	0	0	0
		Average	-	-	-	-	-	-
		Maximum	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-
Calcium as Ca (ppm)	No.of	Samples	0	0	0	0	0	0
		Average	-	-	-	-	-	-
		Maximum	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-
Magnesium as Mg (ppm)	No.of	Samples	0	0	0	0	0	0
		Average	-	-	-	-	-	-
		Maximum	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-
Sulphite as SO_3 (ppm)	No.of	Samples	0	0	0	0	0	0
		Average	-	-	-	-	-	-
		Maximum	-	-	-	-	-	-
		Minimum	-	-	-	-	-	-

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		Sampling Point Number LS-19	LS-20	LS-21	LS-22	LS-23	LS-24
Phenols (ppb)	No.of Samples	5	4	5	4	5	4
	Average	2	9	9	8	10	4
	Maximum	6	15	20	20	15	6
	Minimum	0	0	2	2	2	0
Total Phosphorus as PO_4 (ppm)	No.of Samples	4	4	4	4	4	4
	Average	0.19	0.21	0.22	0.19	0.22	7.28
	Maximum	0.36	0.32	0.50	0.36	0.40	12.00
	Minimum	0.10	0.08	0.08	0.10	0.14	2.30
Dissolved Oxygen Saturation (%)	No.of Samples	1	1	1	1	1	1
	Average	78	55	27	29	57	25
	Maximum	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

(B) CURRENT RIVER, McVICAR CREEK, McINTYRE RIVER, NEEBING RIVER, KAMINISTIKWIA RIVER, AND MISSION RIVER (i) Sampling Station Locations

Sampling Point Number	Sampling Point Location	Period of Sampling
C-0.3	Current River at Highway No. 11 and 17	July 1966 to April 1968
McV-0.2	McVicar Creek at Highway No. 11 and 17	July 1966 to April 1968
Mc-1.4	McIntyre River at Fort William Road	May 1963 to October 1967
Mc-1.0	McIntyre River at C.P.R. Bridge	May 1963 to October 1967
Mc-0.6	McIntyre River at Hamilton Avenue	July 1966 to April 1968
N-0.2	Neebing River at Tenth Avenue	July 1966 to April 1968
K-5.5	Kaministikwia River at Great Lakes Paper Company Limited Water Works Intake	July 1966 to April 1968
K-4.2	Kaministikwia River at Highway No.61	July 1966 to April 1968
KMc-1.5	McKellar River at Fourth Avenue Bridge	October 1966 to April 1968

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

(ii) Maximum, Minimum and Average Values

Analysis		Sampling Point Number C-0.3	McV-0.2	Mc-1.4	Mc-1.0	Mc-0.6	N-0.2	K-5.5	K-4.2	KMc-1.5
Coliforms per 100 c.c. (M.P.N.)	No. of Samples	6	5	46	46	5	4	12	12	11
	Log. Average	24	766	770	1,493,000	451,700	10,800	446	5,338	8,389
	Maximum	43	9,300	300,000	210,000,000	11,000,000+	43,000	64,000	23,000	43,000
	Minimum	4	75	12	630	930	2,300	20	750	430
BOD_5 (ppm)	No. of Samples	11	14	35	35	13	11	14	13	11
	Average	0.8	2.0	1.5	11.4	10.1	1.6	4.4	10.5	2.9
	Maximum	1.8	10.0	4.0	47.0	30.0	2.3	20.0	36.0	6.4
	Minimum	0.3	0.4	0.4	1.0	2.6	1.0	0.5	1.4	0.4
Total Solids (ppm)	No. of Samples	10	13	35	35	13	9	9	11	8
	Average	63	217	141	204	204	164	172	147	113
	Maximum	90	320	272	358	306	248	670	256	176
	Minimum	28	168	60	108	111	109	58	70	74
Suspended Solids (ppm)	No. of Samples	9	13	35	35	13	10	10	10	9
	Average	3	42	10	28	30	11	18	18	20
	Maximum	9	174	106	196	67	18	57	30	34
	Minimum	1	4	1	3	14	2	2	4	12
Dissolved Solids (ppm)	No. of Samples	9	12	35	35	12	9	9	9	8
	Average	60	175	131	176	174	153	154	129	93
	Maximum	87	246	209	278	261	239	660	202	161
	Minimum	25	77	58	95	83	91	42	42	57

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		C-0.3	McV-0.2	Mc-1.4	Mc-1.0	Mc-0.6	N-0.2	K-5.5	K-4.2	KMc-1.5
		Sampling Point Number								
Turbidity (Units)	No. of Samples	7	9			9	7	7	6	7
	Average	5.7	20.6			31.4	19.9	9.9	20.0	23.6
	Maximum	8.5	41.0			48.0	38.0	27.0	48.0	48.0
	Minimum	2.3	3.1			10.0	9.0	4.0	9.0	9.5
Conductivity (Micromhos per cm^3)	No. of Samples	10	14			14	10	9	9	7
	Average	75	243			282	221	175	125	125
	Maximum	110	353			361	358	890	212	150
	Minimum	48	114			124	144	71	24	112
Total Phosphorus as PO_4 (ppm)	No. of Samples	4	9			10	7	7	7	6
	Average	0.05	0.29			4.28	0.25	0.14	0.66	0.68
	Maximum	0.08	0.86			11.00	0.51	0.36	3.30	2.30
	Minimum	0.02	0.02			0.00	0.04	0.03	0.12	0.05
Soluble Phosphorus as PO_4 (ppm)	No. of Samples	10	13			13	10	8	8	7
	Average	0.05	0.09			2.88	0.13	0.05	0.06	0.08
	Maximum	0.14	0.20			9.00	0.45	0.14	0.10	0.17
	Minimum	0.00	0.01			0.09	0.02	0.01	0.02	0.03
Free Ammonia as N (ppm)	No. of Samples	8	12			10	9	8	8	8
	Average	0.13	0.14			4.76	0.30	0.24	0.31	0.26
	Maximum	0.26	0.36			16.40	0.46	0.66	0.78	0.59
	Minimum	0.02	0.03			0.62	0.18	0.02	0.02	0.09

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		Sampling Point Number C-0.3	McV-0.2	Mc-1.4	Mc-1.0	Mc-0.6	N-0.2	K-5.5	K-4.2	KMc-1.5
Total Kjeldal as N (ppm)	No. of Samples	8	12			11	9	10	9	8
	Average	0.84	0.98			6.50	1.14	1.02	1.37	1.57
	Maximum	2.60	2.60			13.00	3.10	2.30	4.20	4.20
	Minimum	0.33	0.33			2.10	0.52	0.33	0.58	0.58
Nitrite as N (ppm)	No. of Samples	9	12			14	10	10	9	7
	Average	0.010	0.006			0.034	0.021	0.034	0.005	0.004
	Maximum	0.080	0.013			0.340	0.068	0.270	0.015	0.013
	Minimum	0.000	0.000			0.000	0.000	0.000	0.000	0.000
Nitrate as N (ppm)	No. of Samples	9	14			14	10	8	10	6
	Average	0.120	0.373			0.124	0.140	0.136	0.120	0.654
	Maximum	0.250	1.000			0.377	0.460	0.400	0.260	3.000
	Minimum	0.000	0.010			0.000	0.000	0.020	0.020	0.000
pH at OWRC Lab.	No. of Samples	0	0			0	0	2	5	3
	Average	-	-			-	-	7.4	7.2	7.1
	Maximum	-	-			-	-	8.1	7.9	7.5
	Minimum	-	-			-	-	6.6	6.6	6.7
Chlorides as Cl (ppm)	No. of Samples	8	14			13	10	9	8	8
	Average	2	8			17	10	5	11	6
	Maximum	3	24			32	20	19	21	9
	Minimum	1	3			6	5	1	5	4
Calcium as Ca (ppm)	No. of Samples	0	0			0	0	5	6	5
	Average	-	-			-	-	25	15	15
	Maximum	-	-			-	-	80	20	24
	Minimum	-	-			-	-	9	9	9

TABLE VI-6
(Cont'd)

SANITARY WATER QUALITY

Analysis		Sampling Point Number C-0.3	McV-0.2	Mc-1.4	Mc-1.0	Mc-0.6	N-0.2	K-5.5	K-4.2	KMc-1.5
Magnesium	No. of Samples	0	0			0	0	5	5	5
as Mg	Average	-	-			-	-	12	6	4
(ppm)	Maximum	-	-			-	-	31	10	6
	Minimum	-	-			-	-	4	2	2
Sulphite	No. of Samples	0	0			0	0	5	5	4
as SO_3	Average	-	-			-	-	1.6	8.4	2.0
(ppm)	Maximum	-	-			-	-	6.0	34.0	4.0
	Minimum	-	-			-	-	0.0	0.0	0.0
Sodium as	No. of Samples	0	0			0	0	5	5	4
Na (ppm)	Average	-	-			-	-	9.0	7.7	5.7
	Maximum	-	-			-	-	19.0	13.6	7.0
	Minimum	-	-			-	-	1.7	4.0	4.0
Phenols	No. of Samples	7	10			10	8	8	8	7
(ppb)	Average	3	4			11	4	11	35	19
	Maximum	10	8			30	12	40	150	60
	Minimum	0	0			2	0	0	0	4
Dissolved	No. of Samples	11	12			12	9	0	0	0
Oxygen	Average	95	94			53	85	-	-	-
Saturation	Maximum	106	108			93	94	-	-	-
(%)	Minimum	72	76			0	68	-	-	-

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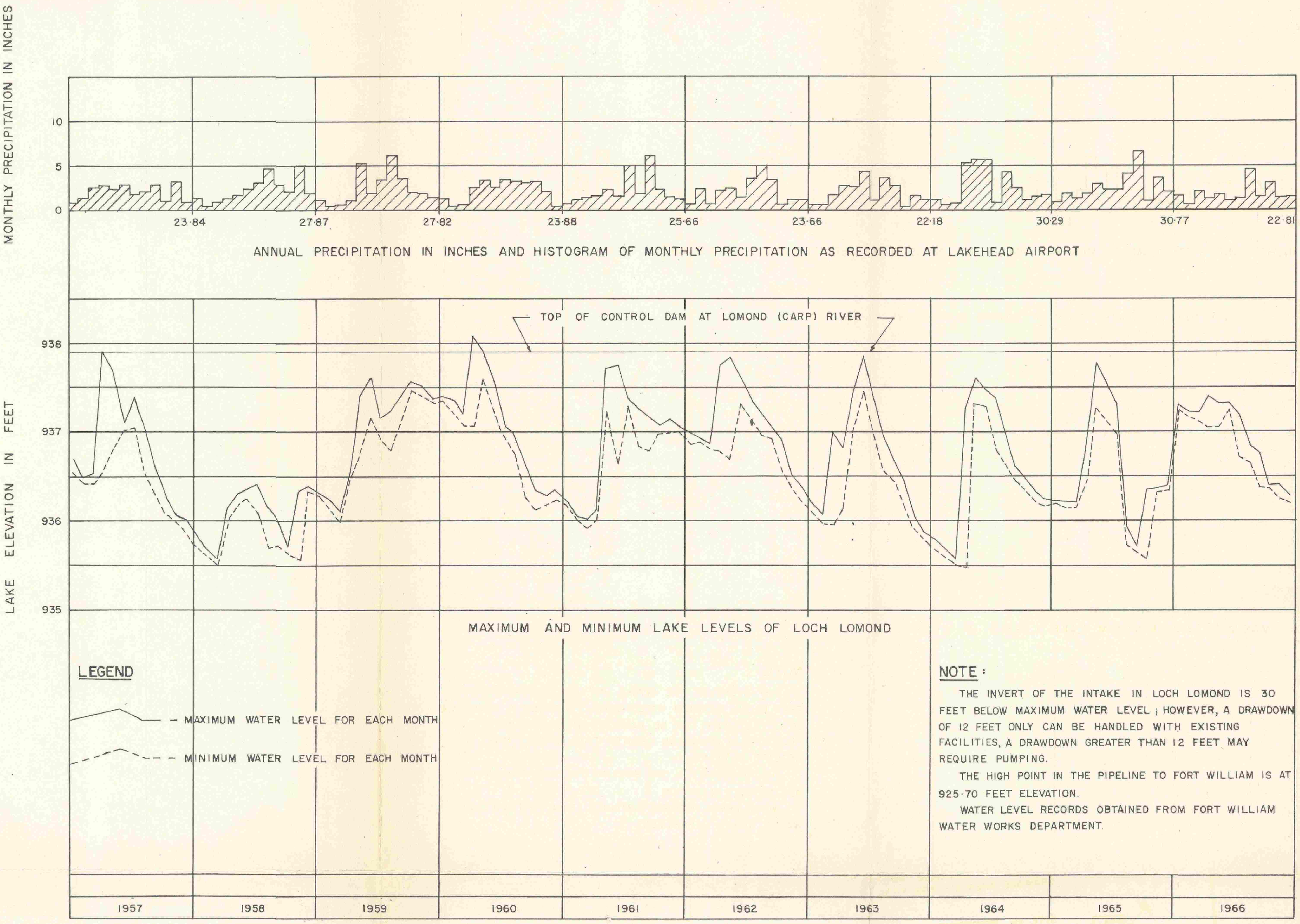

NOTE:

THE INVERT OF THE INTAKE IN LOCH LOMOND IS 30 FEET BELOW MAXIMUM WATER LEVEL; HOWEVER, A DRAWDOWN OF 12 FEET ONLY CAN BE HANDLED WITH EXISTING FACILITIES. A DRAWDOWN GREATER THAN 12 FEET MAY REQUIRE PUMPING.

THE HIGH POINT IN THE PIPELINE TO FORT WILLIAM IS AT 925·70 FEET ELEVATION.

WATER LEVEL RECORDS OBTAINED FROM FORT WILLIAM WATER WORKS DEPARTMENT.

ONTARIO WATER RESOURCES COMMISSION	
LAKEHEAD AREA WATER SUPPLY AND POLLUTION CONTROL STUDY FIGURE IV - 2 MAXIMUM AND MINIMUM LAKE LEVELS OF LOCH LOMOND AND PRECIPITATION RECORDS AT LAKEHEAD AIRPORT 1957 — 1966	
SCALE : AS SHOWN	
DRAWN BY : L. L. BROOME	DATE : JULY, 1967
CHECKED BY : W.L.	DRAWING No: 67 — 99


ONTARIO WATER RESOURCES COMMISSION
LAKEHEAD AREA
WATER SUPPLY AND POLLUTION CONTROL STUDY
FIGURE III-2
DEVELOPMENT TRENDS
SCALE : 2 0 2 4 MILES
DRAWN BY : L. L. BROOME
DATE : AUGUST, 1967
CHECKED BY : W. L.
DRAWING No : 67-43
LEGEND
— BOUNDARY OF STUDY AREA
— BOUNDARY OF DRAINAGE AREA WHEREVER DRAINAGE AREA DIFFERS FROM STUDY AREA
2AB6 — SITE OF RECORDING STREAMFLOW GAUGING STATION AND GAUGE CODE NUMBER
— WATERSHED BOUNDARIES
— DRAINAGE AREA BOUNDARY
W — EXISTING WATER WORKS
S — EXISTING WATER POLLUTION CONTROL PLANT
I — DENOTES INDUSTRIAL PLANT
— EXISTING DEVELOPMENT
— 1988 DEVELOPMENT
— ULTIMATE DEVELOPMENT
THUNDER BAY
LAKE SUPERIOR
PORT ARTHUR
FORT WILLIAM
WELCOME ISLANDS
PIE ISLAND
FLATLAND ISLAND
KAKABEKA FALLS
KAKABEKA FALLS PROVINCIAL PARK
POWER PLANT
KAMINISTIKWIA
MURILLO
JELLY
KIVIKOSKI
TOIMELLA
STEPSTONE
DOG FALLS
MISSION BAY
GRAND POINT
SQUAW BAY
POINTE DE MEURON
RESERVOIR
FORT WILLIAM INDIAN RESERVE
TWP. OF FOWLER
TWP. OF WARE
TWP. OF JACQUES
TWP. OF GORHAM
TWP. OF MacGREGOR
TWP. OF McINTYRE
TWP. OF OLIVER
TWP. OF CONMEE
TWP. OF O'CONNOR
TWP. OF PAIPOONGE
TWP. OF NEEBING
TWP. OF SCOBLE
TWP. OF GILLIES
TWP. OF SLATE
TWP. OF BLAKE
TWP. OF PEARSON